SCHOOL SCIENCE AND MATHEMATICS

VOL. XXXIII, NO. 2 FEBRUARY, 1933 WHOLE NO. 283

THE RESPECTIVE ABILITIES OF BOYS AND GIRLS IN LEARNING GEOMETRY

BY LAURA BLANK

Hughes High School, Cincinnati, Ohio

Is there any subject of the curriculum more discussed in its connection with the abilities of the respective sexes, their respective achievements and successes than geometry? Teachers of mathematics encounter, from girls, such opinions and prejudice as this: "Mother had difficulty with geometry. All of the women of my family have struggled with it. Girls never do as well as boys in their study of geometry, do they?" One actually hears teachers of mathematics occasionally make statements to one another almost as sweeping in their scope. Moreover teachers, at times, make remarks to this purport to pupils.

The question of the transmission of any such ability, as ability in geometry, by heredity, is one that probably never can be settled scientifically. Nor is it the intention in this paper to consider such an issue or to attempt to come to any conclusion concerning it.

For thousands of years, the literature of opinion has been pointing out sex differences in personality. The literature of fact, that is, of scientific analysis, for the last twenty-five years, has been depicting in detail study after study of sex differences in personality. The consensus of scientific opinion to-day is that, aside from the primary sex functioning, in general, there is very little difference between the sexes in intelligence, in achievement, or in personality. In fact, the other students of psychological experiment agree with Thorndike when he says that in intellect and character "the average man differs from the aver-

age woman by far less than many men differ from one another."

"In no trait of those studied has a gap been found between the distributions of the two sexes. The upper limit of one sex always overlaps the lower extreme of the other."[1] Moreover the male sex is more variable than the female showing a greater range of types from the genius to the idiot.

There seems to be fair agreement among the experimenters that the characteristic of intuition is stronger in women than in men whereas there is somewhat greater ability among men to reason slowly and impersonally and clearly from an hypothesis to a desired conclusion. There are slight differences apparent in other traits of character, which however would have little bearing upon our present interest.

Some students of psychology and geometry claim that this characteristic of greater intuition on the part of girls and women makes them quicker and more adept in seeing through to the conclusion in work in geometry. Other research scholars claim that the impersonal, slower, clean cut reasoning of boys and men is a greater asset in the study of geometry.

Knight Dunlap[2] says: "In logical memory (as distinguished from rote memory), where the significance of what has been studied is to be retained, regardless of form, there is no clear difference in the sexes; although it is sometimes assumed that males are superior in this."

Three noteworthy studies have been developed recently in an effort to determine the geometric abilities of girls as compared with boys. We shall consider them in the order of their publication.

F. C. Touton, in 1924, published an account of a critical study[3] of preference expressed for certain types of geometric originals by 2800 New York high school pupils, and of the achievements of these pupils in solving the originals selected. The exercises considered were included in the 1918 Regents' Examination list from which pupils were required to select and solve at least four. Four theorems were to be proved also, or, if it was preferred, as many as eight exercises might have been selected, in which case, no theorems were to be proved. The papers studied were a random sampling of the papers from this state examination so as to secure approximately five hundred

---

[1] Thorndike, E. L., *Individuality* (New York: Houghton Mifflin and Company, 1911), p. 30.

[2] Dunlap, K., *Social psychology* (Baltimore: The Williams and Wilkins Company, 1925), p. 35.

[3] Touton, F. C., Sex differences in geometric abilities. *Jour. of Ed. Psych.* 1924, 15, 234–247.

solutions by each sex of each exercise. The object in the selection was to be in a position to contrast fully sex differences in interests for what would be, because of this selection, the upper portions of the groups.

As work done in solving original exercises in geometry is considered by teachers of geometry to be a better measure of achievement in geometry than work done in reproducing proofs of theorems, it was decided to study only work done by pupils in their attempts to solve the thirteen original exercises listed.

The results of this investigation show that the one construction exercise presented makes a decidedly stronger appeal to boys than to girls. In the "ability to solve geometric originals" the median boy *does* excel the median girl, yet the "characteristic fact about the observed difference is its small amount." In the case of each of the thirteen exercises presented, a higher percentage of boys than of girls made perfect scores on the exercises selected. Along with the strength of the preference shown by the boys goes corresponding success in excelling more than one-half of the total group in solving the exercises selected. In all exercises, except one, the boys of the selected group under consideration are less variable in the mental trait called "ability to solve geometric originals" than are girls. In general, the measures of ability to solve geometric originals which were made in the study for the selected groups here considered that boys are less variable than girls.

The next study to be considered is that of P. E. Webb, published in 1927,[4] in which he took into consideration the geometric abilities and achievements of such boys and girls only as were of equal mental abilities.

The Terman Group Test of Mental Ability was used in conjunction with the Webb Geometry Tests, Form A and B, both of which tests have been shown to be both valid and reliable. The tests in geometry were given during the last week of the semester to 410 boys and 349 girls who were completing the year's course in geometry. These pupils took both forms, the second form following the first in from one to three days. The entire number of boys tested was 624 and of girls 506, some of whom took only one form. The basis for the classification of the students was mental age as determined by the Terman Group Test for Mental Ability.

[4] Webb, P. E., A study of geometric abilities among boys and girls of equal mental abilities. *J. Educ. Res.*, 1927, 15, 256–262.

Making one comparison without reference to mental ability, the mean score for the boys is higher than that for the girls. With classification into groups of various mental-age levels other differences appear:

1. The superiority in geometry of the boys over the girls of the same intelligence seems to be the most marked at the lower mental-age levels where we find the greatest and most significant differences between the mean scores in geometry of boys and girls.
2. Girls having mental ages of more than eighteen years six months not only seem to do work in geometry much superior to girls in the lower mental-age groups, but also seem to excel the group of boys of equal ability.
3. Girls, in general, attain one more year of mental maturity than boys before their achievement is comparable to that of boys.
4. In geometric ability, girls are more variable than are boys when the middle 68 per cent of the cases are considered.
5. The differences in geometric achievement between boys and girls at different mental-age levels tend to show that those studies of sex differences, which neglect to take into account the factor of mental ability, fail to discover significant differences between sex groups which may exist at one mental-age level, but not at another.

A third investigation, the account of which was published in 1929, was carried on by W. M. Perry[5] with three groups of high school pupils, two control groups and one experimental group, with which the investigator attempted to answer the question: Can students be taught to attack the solution of exercises in plane geometry with the assurance either that they can be successful during the first trial, or, if unsuccessful in the first attempt, can they retrace their steps only to that part necessary in order to redirect their thinking? This question was answered affirmatively. Then the experimenter examined the data of this investigation to determine whether the boys were equal, superior or inferior to the girls in the solving of certain originals in geometry.

A comparison is made in the chronological ages of the groups. The boys vary little from the girls. In mental age and in ability to reason the boys as a group exceed the girls.

Three tests in exercises were given, each including three originals. In general the girls excelled the boys in their ability to solve exercises in geometry. "A searching technique was used to ferret out subtle factors operating during the actual process of solving exercises in geometry."

In general, the conclusions of this investigation are:

---

[5] Perry, W. M., Are boys excelling girls in geometric learning? *J. Educ. Psych.* 1929, 20, 270–279.

Although as a group the boys were somewhat higher in general mental ability and in reasoning ability, the girls reached a higher degree of achievement in the solution of exercises in geometry. The degree of superiority in achievement depended less upon the ability group and the division membership of these students and more markedly upon the nature of the step. Adequate responses to the "given" steps were found nearly as frequently among girls as boys, though tending slightly in favor of the boys. Ability to respond adequately to the "link" steps, however, was more characteristic of the girls. This ability led to somewhat higher achievement, also on the part of the girls, in responding the more adequately to the step combinations within the several exercises. Therefore it proved to be the girls who were the more superior in responding more adequately to the solutions of exercises in geometry. Especially were the girls the more superior in responding to those "link" steps by means of which they were able to bridge the gap between the given relations (those observed with the pertinent recalled facts) and the required relations which had controlled the direction of the processes of thinking during the actual solving of the exercises in geometry.

It is apparent, then, that the investigators with all of their careful technique and effort to arrive at scientific conclusions are in no more agreement in the matter of sex differences in geometric learning than are other experimenters in the problems of other sex differences in personality.

Further experiments on the subject of sex differences in geometric learning may show such differences to be nonexistent or of such trivial character as to be regarded as of minor importance or as negligible.

MOTION PICTURE FILMS

An extensive list of sources of commercial and trade promotion films suitable for classroom use has just been issued by the Motion Picture Division of the Bureau of Foreign and Domestic Commerce, Department of Commerce, in a 17 page pamphlet known as the "Composite List of Nontheatrical Film Sources," which gives the names and addresses of 524 concerns which have such films for distribution.

This pamphlet is suggested as an authentic list of film sources to be used by those who may be interested in securing films for nontheatrical exhibition.

A brief code is given listing the conditions under which each individual concern releases its films. As an example, it is indicated as to whether the films are available free of charge or otherwise, whether they are silent or sound, 16 or 35 millimeter in size and whether they are printed on inflammable or non-inflammable stock.

Copies of the pamphlet may be secured for 10 cents each (stamps not acceptable), from the Motion Picture Division, Bureau of Foreign and Domestic Commerce, Washington, D.C., or from the Bureau's District Offices.

CHEMISTRY IN 1858

BY OTTO J. WALRATH
High School, Bloomfield, New Jersey

We are hearing about the new philosophy of education. We have some wonderful theories to explain many of the chemical phenomena. In the following article the author has quoted from a chemistry text of some seventy odd years ago, with the idea of showing (1) the educational aims and objectives of that time, (2) some of their theories, and (3) a few of the important changes that have taken place in the content of our important science.

"This work has been prepared with special reference to the wants of students in Academies, Seminaries, and Colleges, aiming to furnish just that information which will prove most useful and practical in their future employments and relations of life.

"The great general principles of chemistry, and the more important of the elements and their compounds, have been accordingly very fully discussed; while on the other hand the custom adopted in many textbooks of enumerating and describing compounds which have no practical value and little scientific interest, has been disregarded.

"To enable the student to understand more clearly the relations which chemistry sustains to the industrial operations of the age, and to the past and present progress of civilization, greater attention has been given to the history of the science than has heretofore been customary in elementary text-books.

"Special care has also been taken to present the very latest results of scientific discovery and research, in this country and in Europe, and to take advantage of the most approved methods of experimentation and instruction.

"An unusually large number of illustrations has been introduced, with the double purpose of rendering the study of the science more intelligible and attractive to the pupils, and of facilitating the instructions of teachers, especially of those not enjoying the advantage of large apparatus."

The above is not a statement of educational philosophy written in 1932, although it might have been written then since it sounds so familiar. It happens to be part of the Preface of Well's Principles of Chemistry, written in 1858 and published by Ivison, Phinney, Blakeman & Company. The copy of the text was found by one of my students in the attic at home, and, thinking

I might like it, she presented it to me. To say that I was interested is to speak mildly, as I have read it cover to cover, some parts, in fact, several times. With the idea that others might also be interested, I have "dug" out some of the contents and am passing them on in this article.

The final paragraph of the Preface is "In respect to originality the author makes little pretension beyond the arrangement and classification of subjects, and the selection of illustrations. Among the authorities to which he is especially indebted he would mention Faraday, Prof. Miller of King's College, London, Graham, Regnault, and Hayes."

The first 150 pages are given up to physics with chapter headings as follows: (1) On the Connection of Gravity, Cohesion, Adhesion, and Capillary Attraction with Chemical Action, (2) Heat, (3) Light, and (4) Electricity. The inclusion of physics in the text is explained by the author as follows: "The connection, however, between chemistry and natural philosophy is most intimate; and all chemical changes are influenced to such an extent by the action of the physical forces, that a knowledge of the principles of natural philosophy is requisite for a proper understanding of the nature of chemical phenomena. . . ." The first part of this work is, therefore, devoted to a consideration of the nature and action of the physical forces so far as they are concerned in producing chemical changes, or in characterizing chemical phenomena."

In the chapter on electricity the explanation of the simple galvanic cell and its production of the electric current is very interesting. "When a plate of zinc and one of copper are immersed in water acidulated with sulphuric acid, the elements, oxygen and hydrogen, are separated from each other, in consequence of the greater attraction which the oxygen has for the zinc. The oxygen, therefore, unites with the zinc, and so doing excites, or develops electricity in the metal. But as one kind of electricity can not be evolved without bringing an equal quantity of the other into activity, the act which develops negative electricity in the metal, instantaneously develops positive electricity in the liquid. It would naturally be supposed, that as the two opposite electricities have a strong attraction for each other, that they would again unite, and restore the equilibrium; such, however, from some unexplained reason, is not the case; but the electrical and chemical changes are so connected, that unless the equilibrium is restored, the action between the metal

and the liquid will stop as soon as a certain quantity of electricity has accumulated. If, under these circumstances, the copper plate which is immersed in the liquid, but not acted upon by it, be brought in contact with the zinc, it will serve as a conductor, and will convey the equilibrium of the two electricities, and cause the action between the liquid and the zinc to recommence. With the commencement of the flow of positive electricity fom the liquid to the copper, and from the copper to the zinc, a current of negative electricity will tend to flow in the opposite direction, or from the zinc to the copper, and from the copper to the liquid.

"In every voltaic current it is assumed that a quantity of negative electricity, equal to that of the positive set in motion, is proceeding along the conducting medium in a direction opposite to that in which the positive electricity is travelling; but in order to avoid confusion, whenever the direction of the current is mentioned, the direction of the positive electricity is alone referred to."

In the chapter on hydrogen, where water is discussed we find "Waters which contain 6 grams of organic matter to the gallon are not fit for domestic use; if this limit is exceeded, they act disastrously upon the animal economy .... The presence of magnesia in considerable quantity in drinkable waters is undoubtably injurious; the use of such waters in Switzerland is supposed to give rise to the frightful diseases known as "goitre" and "cretinism." Concerning hydrogen peroxide, "The known properties of this substance render it highly probable that it would prove most valuable in its application to art—as a bleaching and oxidizing agent. The expense and difficulty attending its preparation have, however, thus far prevented its employment for any practical purpose."

Chloride of lime is described as "almost a monopoly with Great Britain, and no attempt to prepare it on a large scale in this country has ever been successful. The reason why the manufacture of bleaching-powder has not been introduced into the United States, is due doubtless to the fact, that it can only be economically conducted in connection with the manufacture of soda-ash, which process furnishes hydrochloric acid, from whence chlorine is prepared at a mere nominal cost; and to carry on both operations advantageously requires the employment of great capital and skill."

The idea that carbon dioxide is poisonous is pointed out with

the statement that "When diluted with air, it may be breathed without difficulty, but if the proportion in which it exists in the air exceeds 4 per cent, it acts as a narcotic poison. . . . The drowsiness and headache experienced in crowded and ill-ventilated apartments are chiefly due to the accumulation of carbonic acid as the resulting product of respiration." Referring to illuminating gas and its history the author says, "Gas was first employed for street illumination in London in 1812, and in Paris in 1815. The majority of householders in London were opposed to its introduction into the streets of that city, and for many years the advocates of the use of gas for general illumination, encountered a great amount of opposition and ridicule."

The price of aluminum in 1858 was twice that of silver. The value of crude platinum was about half that of gold; but in the manufactured state it was worth from $18 to $20 per ounce, while gold was worth from $16 to $18 an ounce. Milk, or sugar mixed with iron filings was recommended as an antidote against copper poisoning.

Organic Chemistry is defined as "that department of science which treats of the chemical nature and relations of those substances which are derived, either directly or indirectly, from organized beings—animal or vegetable." The formulae of some of the organic compounds are: cane sugar—$C_{12}H_{11}O_{11}$, glucose—$C_{12}H_{14}O_{14}$, Lactine—$C_{24}H_{24}O_{24}$, wine alcohol—$C_4H_6O_2$, proteine $C_{36}H_{25}N_4O_{10}$ and fibrine $C_{400}H_{310}N_{50}O_{120}PS$.

The electro-chemical order of the elements is arranged as follows:

sulphur
nitrogen
chlorine
fluorine
carbon
phosphorus
hydrogen
gold
platinum
mercury
silver
copper
tin
lead
iron
zinc
sodium
potassium—Electro-positive

The explanation of the decomposition of water by electricity is very striking. "The arrangement of the particles constituting a line or layer of water between the poles of a galvanic circuit may be represented as follows: the positive atom, hydrogen, of each particle of water being turned by the influence of the electricity toward the negative pole, and the negative atom, oxygen, toward the positive pole—Positive pole—OH, OH, OH, OH—Negative pole.

If the positive pole is placed on the left and the negative on the right, oxygen passes off from the first, and hydrogen from the last . . . . It is not, however, to be supposed that when H, is liberated from O, at the negative pole, that the O of that particle passes over along the line to the positive pole; but the view taken is, that as soon as the atom of oxygen loses its hydrogen, it combines with the atom of hydrogen of the next particle of water, and a new particle of water is reproduced. The oxygen of the second particle being thereby liberated, combines with the hydrogen of the next particle of water, and thus the decomposition and recomposition is continued on to the end of the series. Resorting again to symbols, No. 1 will represent the state of things before any change has been effected, and No. 2 the change after the circuit is completed—

No. 1+OH, OH, OH, OH, OH . . .
No. 2+O, HO, HO, HO, HO, H . . .

It should also be borne in mind, that the changes described are not successive, but simultaneous at each end of the series of particles, and at all intervening points in the line of the series."

As one reads and digests some of the theories so plausibly given to the students of seventy years ago, one wonders how some of our explanations and theories will appear to the students of 1958.

CONSERVATION IN WINTER

BY HENRY BALDWIN WARD

University of Illinois, Urbana

All of us who love the outdoors and want to see our country pay more attention to the preservation of woods, waters and wild life, are prone to think that this is the season when we may lay off from our work for these things and if we cannot like the birds, seek a warmer clime, we can at least crawl into our holes like the ground hogs and squirrels and wait for a promise of returning sunshine and the new blossoming of another spring. "Now is the winter of our discontent" and while those of us who are optimists may plan for another year, too many of us have the shade of pessimism in our makeup that tempts us to talk of the spring that we wished were here with its richer opportunities for outdoor life.

In truth this is a short-sighted policy. If we turn our eyes to things that can be seen now, winter will show us some things more vividly than they appear in the growing seasons of the year, and give to us a clearer idea of just what ought to be done to make the outdoors what it should be and to keep it in that condition. Now is the time when teachers can find opportunities on every hand to point out some errors in our national habits and opportunities, to locate these abuses and to measure their extent. When snow covers the landscape and makes the blood of the wanderer leap as he struggles through the drift, filled with admiration of the beauties of the scene around him, even under these circumstances it is not difficult to detect the evidences of our short-sightedness and gain information which will stand us in good stead as we fight the long battle for the correction of evil habits and the achievement of better conditions. Let me mention briefly some of the things which will impress the student once that attention is directed to them.

What can be lonelier and sadder than the winter aspect of a field of bare stumps no longer half hidden by the rich plant growth of summer or garlanded with tints of autumn? The bare stumps stand out as mute evidences of the destruction that has taken place. Although as a teacher you may have considered the extent to which destruction of trees has progressed in this beautiful prairie state, I am sure that your pupils have rarely if ever thought of it and even your estimate of the situation

will be far below the facts of the situation. One lover of trees, walking through the streets of a good sized town in Illinois, counted over five hundred trees that had been cut down within the last year or two and their bare stumps left as evidence of the beautiful shade trees that only recently had lined these walks. In all that town he found few places where the stumps had been grubbed out and less than twenty-five young trees which had been planted to take the place of those that had been removed. Another friend of mine who loves the trees and travels rather widely through central Illinois told me of one trip where he counted in cut over wood lots or former pieces of forest land, several thousand new and ugly stumps and not a single place where foresight had been exercised to replace the lost forest. You know that without forests we cannot have birds and streams and a multitude of other attractive features. Why not have your classes make a survey of city streets or of suburban lots or country woodland to see for themselves how much has been lost and to what extent replacement has been attempted? Follow it up by having them for themselves think up and record the other forms of life, good or bad, attractive or otherwise, that have been affected by these changes and strike a balance if they can. The figures and the records that they secure will surprise all.

This study can easily be carried much further. Fall and spring with their heavy rains and floods and even winter thaws are the times when streams are seriously eroded and when without trees as protection for banks, the creeks cut back into fine farm land and damage valuable tracts. Let no one think that because agricultural prices are low today it is worth while to disregard the effects of that type on agricultural areas and valuable farm land. The classes will easily see when bushes are bare and grasses are beaten down to the ground level, how the floods and high water eat into the banks and change the course of the stream, fill up its holes, and transform it into a broad shallow bed without the deep holes and dark corners in which the fish hide and where in better days one could find some old fisherman with his pipe, waiting for a bite. The careful study in definite localities of the destructive work of water in the winter season, both on fields and in streams, will give a better appreciation of the transforming effect of this agency than can be secured at any other time of the year.

Then one thinks of the sad but ever present factor of pollution,

more clearly evident in the low and often half-stagnant waters of winter time than in the fuller flow of other seasons. It is not difficult to mark its effects in the stained and dingy ice along the shore, in the waste that appears stranded on the shallows, in the unpleasant odors that fill the air. At other seasons the beauties of the fields and the flowers and the forests draw the mind away from these ugly things and make them less impressive. Our classes ought to see and realize the extent of the evils due to the reckless and indiscriminate discharge into streams of untreated wastes; and the somber surroundings of winter make the situation clearer and more convincing than at other seasons.

There is another feature all too conspicuous in the more thickly settled parts of our country and especially conspicuous near cities. It can be seen even in beautiful suburbs and not far from elegant residences and handsome properties. Here and there, and sometimes everywhere along the stream bed, in shallows or on the bank, appear relics of civilization in the form of broken crockery, old tin cans, waste fragments of iron and other materials that have been thrown away and have come to rest here. The prevailing carelessness and thoughtlessness as well as the unfortunately widespread idea that a stream is a good place for refuse, have degraded our small water courses as well as often larger streams to the level of a sewer. In a bend of one of the loveliest little rivers in Illinois and near attractive summer cottages in a landscape that ought to have been lovely, I saw on one of my rambles an old stove, a broken-down portable refrigerator and a rusty bed spring which some cottager had rejected and left as a scar on the landscape which time will be slow to remove.

In most parts of our cities and suburbs one can easily find places near the schools where such things can be seen and where a definite record made by a class soon becomes the talk of the neighborhood and tends to develop a proper sense of public pride which is not content merely with protesting against such conditions but under the continued influence of discussion in schools develops to the point of insisting upon measures for the correction of the situation. Let us not forget that a time of depression is one in which all of these features of neglect are accentuated. We have much to do and less to do with than in better times. Consequently, there is reason for greater care, for more definite realization of the situation on a large scale. This is the time when public lands can be quietly taken over for pri-

vate purposes. The watch dogs are occupied elsewhere and the tresspassers can make their way into public properties more easily. Even in the smaller things the pressure of circumstances leads to neglect of public situations. How much better it would be that part of the relief necessarily and properly given to those who cannot find work, be utilized to clean up our cities, to make parks, streets, streams, and alleys more sightly and to protect the community against the accumulation of that which becomes an increasing blemish and all too easily a permanent eyesore?

The best way to handle these problems is in my opinion through public schools. The youthful mind is more open to suggestion, less given to dismissing the evidence of undesirable conditions, more likely to keep talking about things, less easily diverted by some trivial and inconsequential reply from the discussion of these undesirable conditions which can be found in every community. Through proper training we can bring the men and women who will control situations in the future years to appreciate now the need of correcting these evils and of avoiding their recurrence. Those who have become habituated to such conditions through years of contact with bad habits are not easy to move and can be brought to action only through vigorous, direct and lasting pressure. That pressure can be exerted by our high school students whose minds are open to the realization of the situation and who as missionaries in neighborhoods and family circles, spread the gospel of righteousness and build up public support for more trees, more clean streams and the country more like God made it.

TWO SCIENTISTS HONORED BY PLANT PHYSIOLOGISTS

Years of research on the composition of plant proteins by Prof. H. B. Vickery, biochemist of the Connecticut Agricultural Experiment Station, were given recognition by his fellow scientists, in the award of the Stephen Hales Prize of the American Society of Plant Physiologists. This prize, a cash award of one hundred dollars, is given by the Society as recognition of outstanding research in plant physiology. It was established some years ago, and named in honor of Stephen Hales, an English clergyman and humanitarian of the eighteenth century, who pioneered in the science of the life processes of plants.

At the same meeting of the American Society of Plant Physiologists, the Charles Reid Barnes Life Membership was awarded to Prof. Charles F. Hottes, head of the botany department at the University of Illinois. This award consists in a paid-up life membership in the Society, from a fund established as a memorial to the late Dr. Charles Reid Barnes, first professor of plant physiology at the University of Chicago. It is given annually to a member of the Society.

ELEMENTARY SCIENCE LESSON FOR KINDERGARTEN

BY WINIFRED M. BARRETT

Kindergarten, Lexington School, Rochester, New York

The Squirrel: His Characteristics and Habitation

Take the children on an excursion in the autumn, preferably to the park, to see the squirrel and his surroundings; falling leaves, nuts, etc.

The next day let the children relate their experiences while on the trip. Show pictures of the squirrel and his surroundings.

Ask these questions to stimulate the children's powers of observation.

What does the squirrel look like? (size, form, and color). Compare with rabbit.

Call children's attention to the squirrel's protective fur—hard to distinguish from his surroundings, and keeps him warm in winter.

Where does he live? (woods and parks)

Where and how does he make his home?

What does he eat?

What *kind* of nuts does he eat?

What kind of teeth must he have to be able to crack these nuts?

What kind of claws has he in order to be able to climb trees?

Is he lazy or ambitious? Develop word "frisky."

What will he do in winter when there is snow on the ground instead of nuts.

At this point a story of "The Squirrel Family" that lived in the woods and gathered their store of nuts can be told to the children.

Emphasize the squirrel's ability to take care of himself, his independence of man. Nature protects him and so should we. Bring out the difference between the squirrel as a lover of the outdoors and the home pet, who depends upon man. The squirrel likes to be free and should not be molested.

In rhythm children can dramatize squirrels running around under the trees and gathering nuts and storing them.

In activity work let children make squirrels with plasticine or clay. Another day they can draw squirrels on the blackboard and with crayons on paper.

Note: This lesson would extend over three days or a week

SUPPLEMENTARY MATERIAL

Story—The Squirrel Family.
Dramatization—Five Little Squirrels Sitting in a Tree.
Humorous Song:

"One day as Mr. Squirrel
Went up his tree to bed
A very large hickory nut
Fell upon his head.
'Although I'm fond of nuts,'
Mr. Squirrel then did say,
'I'd very much rather
That they didn't come that way.' "

Here are some nature *rhymes* and *rhythms* worked out by the children and teacher as a result of studying the squirrel and his surroundings and his neighbors of the woods. We called it:

"RHYTHM OF THE WOODS"

(Music was adapted to each rhyme)

"Fly, little birds, fly far away;
Fly to the South, you cannot stay."
(Children are flying birds.)

"The wind blows the trees,
And down fall the leaves."
(Children imitate swaying branches to waltz tempo with their arms.)

"Leaves are falling on the ground,
All around, all around."
(Children dance and whirl and fall to ground.)

"Leaves all yellow, brown, and red,
This is how they go to bed."
(Children lie still, rest.)

"The little squirrel runs around,
And gathers nuts upon the ground."

(Children scamper around on all fours, and when music hesitates they sit up and put nut in mouth and puff out cheeks. This they liked because of the humor.)

"Big Bears, little bears,
Black bears, and brown,
This is how they walk around."
(Children walk on all fours and find winter holes and curl up for a long sleep.)

When the spring sun shines and the birds sing:

"Out comes the old Bear
To dance in the fresh spring air."
(Children stand up and imitate dancing bears on two feet with paws up.)

"A great big giant is very tall,
A wee, little brownie is very small."
(Children are giants with long steps and then brownies with short stealthy steps.)

"Indian with paint and feather,
Come now, pow-wow altogether."
(Indian dance.)

The children really felt the characteristics of the living plant and animal life in the woods through these rhymes and characteristic rhythms. It was a fine review in nature and rhythm.

COMMENTS

These comments are to indicate the setting of the preceding lesson in elementary science as planned and executed by Miss Barrett. At the outset it should be stated that the program in elementary science in the Rochester Schools is in the making and, therefore, is very tentative in character.

As a result of recent reorganizations in the entire school program from the Kindergarten to the twelfth year new tentative courses of study have been devised and a new time allotment, particularly in the elementary school, has been determined. This time allotment provides sixty minutes

per week for science for the first six grades and thirty minutes per week for the Kindergarten.

Four major objectives have been set up for the elementary school as follows:

I. Tools of Learning
II. Health and Nature
III. Social Relations
IV. Fine and Practical Arts

The work in relation to all four objectives for the elementary school is integrated through the functioning of what may be called centers of interest. For example, the centers of interest for the Kindergarten are Home and School interests, and Neighborhood interests. The science work in each grade attempts, as far as it is practicable, to enrich the meaning of the centers of interest set up for that grade.

The elementary science course is organized under three main heads: Living Things, Physical Environment, Health. In connection with health it should be pointed out that the main responsibility for health work lies with the Health Education Department. However, science should and does make its very essential contribution to the health program.

Under Living Things the following general topics are developed progressively from the Kindergarten to the sixth grade: Animal Life; Plant Life; Adaptation to Environment. The Physical Environment is developed progressively under the topics: The Heavens and Seasons; The Weather; Earth Study; Air.

Elementary science is being introduced into our elementary schools gradually. This method has resulted in a healthy interest and growth in that schools where the principal and teachers become interested the work has progressed very satisfactorily. Moreover, in each school there are certain teachers who are interested in and have had contacts with nature. These teachers are becoming, in a sense, the leaders in their respective schools.

This lesson is presented solely because it represents a workable lesson, and because it may contain suggestions for some other teacher who is trying to find a way of teaching elementary science. It is hoped that this will be one of a series of lessons prepared by different teachers and presented to other teachers through the pages of SCHOOL SCIENCE AND MATHEMATICS. The writer of these comments believes that only by an exchange of ideas of this sort will elementary science develop as it should in the elementary school. He hopes, therefore, that some who read this lesson will send to him lessons which they have tried, and which they think work. No lesson is perfect. Therefore those who are willing to cooperate in this study should not hesitate to send in material on the grounds that it is not good enough. Who knows? It may prove to be the best.

HARRY A. CARPENTER, *Elementary Science Editor*,

That country is the richest which nourishes the greatest number of noble and happy human beings.—RUSKIN.

SUGGESTIONS FOR A CLASSIFICATION OF GEOMETRIC THEOREMS

By Elmer R. Brill
3039 Flournoy Street, Chicago, Illinois

Bertrand Russell has stated that modern mathematics is founded upon the distinction between "all" and "some." Whenever England's great mathematician, with his customary prodigality, scatters such nuggets, many of us have learned from experience that it would be well to plunge in the spade of discovery, for we are sure to uncover a gold mine.

There are theorems of hypothesis and conclusion and other theorems that are bare statements of an analytic or synthetic judgment, in which the hypothesis and conclusion have shrunk to a mere subject and predicate. They state a single relation like aRb (entity a has the relation R to entity b); and, therefore, the converse is true in the sense that the predicate must bear the converse relation to the subject. Where we have hypothesis and conclusion, it will be found that essentially they take the logical form—

If aRb
then $xR'y$,

read "If a has the relation R to b, then x has the relation R' to y". Here we have two relations with a third relation (implication) holding between them, which may take various forms, of which only two are important for our purposes:

1. All aRb situations imply *all* $xR'y$ situations.
2. All aRb situations imply *some* $xR'y$ situations.

All geometric theorems of the ordinary form may be placed in these two categories. Since, in the first case, every aRb situation (hypothesis) can be put into one-to-one relation with every $xR'y$ situation (conclusion), it is evident that for every $xR'y$ situation there *must be* an aRb situation; and therefore, if the conclusion is given as the hypothesis, it must follow that the hypothesis will hold true as the conclusion without any necessity of giving a separate proof. In general we may say that, owing to the reversibleness of space, this universality of implication will usually be found wherever the relations of both hypothesis and conclusion are purely spatial. If the theorem belongs to the second class, we know beforehand that the con-

verse will not be true and that there is no necessity to waste time trying to prove it.

An interesting class of theorems is illustrated by Euclid I.35—"Parallelograms on the same base and between the same parallels are equal to one another" and I.36—"Parallelograms on equal bases and between the same parallels are equal to one another." Props. 37 and 38 make the same statements in regard to triangles. Here we consider triangles and parallelograms bearing three relations. Using any two as the hypothesis and the third as the conclusion, we may form three theorems from the set of relations found in the given theorem. Then any two of such theorems may be considered the converse of the third. We may call such theorems multiconverse, as more than one converse theorem is possible. The truth or falsity depends upon the generality or particularity of the relation used as the conclusion. A general conclusion is true, a particular conclusion is only potentially true.

In Props. 40 and 41 there are four relations, giving three converse theorems. Prop. 40 states that "Equal triangles, on the same base, and on the same side of it, are between the same parallels." Here the general conclusions are still true, but the increased data allows some of the particular conclusions to be true also; and no general rule can be given. The field has been restricted by increased data so that certain of the particular relations attain the force of a universal. In general, we may say that multiconverse theorems are not readily amenable to logical rules. For this reason we shall put them in a special class. The theorem deduced from Euclid III.1 is a remarkable example of this class—"Every straight line which bisects a chord, and is at right angles to it, passes through the centre of the circle." If we add "and bisects the arcs determined by the chord," we have four particular space-relations that are known to exist simultaneously between a certain circle and two of its chords. Given a circle O and chords a and b, the four relations are:

1. Chord a bisects chord b.
2. Chord a is at right angles to chord b.
3. Chord a passes through the centre of O.
4. Chord a bisects an arc determined by chord b.

The field being restricted to a particular figure (circle) and two chords, we find that any two relations are enough infallibly to imply the other two. As a result, we can form six theorems—all true. We may consider one of these III.1 (although Euclid does

not mention the bisection of the arcs determined by the minor chord); and two of the five possible converse theorems thereto are partially expressed by Euclid III.3—"If a straight line through the centre of a circle bisect a chord, then it is perpendicular to the chord, and if it be perpendicular to the chord it bisects it." Modern geometers have added suitable corollaries to remedy Euclid's omission of the other converse theorems.

Since the theorem of formal judgment is really an abbreviated form of the first class, we may outline the classes and give their logical formulae as follows:

GEOMETRIC THEOREMS

ORDINARY (Two Relations) — MULTICONVERSE More than Two Relations

CONVERSE TRUE — CONVERSE FALSE

Class A	Class A-1	Class B	Class C
All *aRb* situations imply *all* *xR′y* situations.	All *a*-entities bear the relation *R* to all *b*-entities. (Predicate bears the converse relation to the subject)	All *aRb* situations imply *some* *xR′y* situations. (For the converse to be true, most of these theorems demand that we allow the modality to be changed from necessity to mere possibility, which is not allowable in geometry)	(Converse may be either true or false)

It may be noted that in the second class, the primary relations either do not exist or else are not stressed, and we are simply told that a certain entity that we are assumed to understand (say the sum of the interior angles of a triangle) bears a certain relation to another entity of definite meaning (say a straight angle). These theorems are usually purely quantitative. The futility of attempting to analyze such theorems into two sets of relations may be easily demonstrated. Let us make the test. "If *a*, *b*, and *c* separately bear the relation 'angle of' to the same triangle, then $a+b+c=180°$ (Euclid I.32, second part)." But the relation "angle of" is redundant; it tells us no more than

the substantive "angle," and is, therefore, superfluous. The simplified statement is "$a+b+c=180$," in which the values of a, b, and c are given as "the sizes of the interior angles of a triangle in degrees." Given definitely the class that satisfies the above variables, we have a simple equation; and, of course, $180=a+b+c$ as well as $a+b+c=180$. The converse is true, but it can tell us nothing we do not already know. It may be possible to find theorems whose logical entities can be analyzed into relations; and, if so, then the theorem can be expressed in the first form. Also, in the first class, we may sometimes suppress the hypothesis and conclusion and state the theorem less analytically in the second form; but, none the less, the distinction between the two forms is definite and convenient.

There now remains to give a sample classification of some of the leading theorems in Euclid:

CLASS A

1.4 (Two triangles are congruent if two sides and the included angles are equal), I.5 (If two sides of a triangle are equal, the angles opposite these sides are equal), I.6 (If two angles of a triangle are equal, the sides opposite these angles are equal. Converse of I.5), I.47 (In every right-angled triangle the square on the hypotenuse is equal to the sum of the squares of the other sides), I.48 (Converse of I.47)

CLASS A-1

I.20 (Any two sides of a triangle are together greater than the third side), I.21 (If from the ends of the side of a triangle there be drawn two straight lines to a point within the triangle, these shall be less than the other two sides of the triangle, but shall contain a greater angle. This could be analyzed into hypothesis and conclusion, but such analysis would be irrelevant and meaningless. Just say "Lines $a'+b'<$sides $a+b$, but angle $A'>$angle A")

CLASS B

I.30 (Two lines which are each parallel to a third are parallel to each other. Really a restatement of an axiom—not a theorem) Note—We often find that a particular spatial relation implies a general quantitative relation, the converse of which is not true. Later geometers have given some examples, e.g., Durell and Arnold's New Plane Geometry, Book I, Props. 17 and 18 (Edition of 1930)

CLASS C

I.35 (two converse theorems—both false), I.36 (two converse theorems—one true and one false), III.1, and III.3

Consider I.15—"If two straight lines cut one another, the vertical or opposite angles shall be equal." According to our formula, a will be one straight line, b another, R the relation of

"intersection," x a vertical angle, y the other vertical angle, and R' the relation of equality. Since there is a one-to-one correspondence between every case of intersection of straight lines and every case of vertical angles, we know that in order to have a case of vertical angles we must also have the intersection of straight lines. This also holds good on a sphere, because the "straightness" required is only two-dimensional straightness; and hence the sphere's curvature in the third dimension is irrelevant.

Consider I.27—"If two straight lines which are cut by a transversal make alternate angles equal, the lines cannot meet, however far they be produced, hence they are parallel." a is an interior angle, b the alternate interior angle, R the relation of equality, x is a certain line, y another line, and R' the relation of "not meeting." On a sphere, the added conclusion, "hence they are parallel" is not true, for the non-tangibility of the lines is only a *property* of parallelism, not essential to it. Since straight lines do not exist on a sphere, the application of this theorem thereto must be attended by more or less arbitrary conventions. However, if the necessary conventions are made so that it is valid, it will be found that its converse is also valid. For the hypothesis is the equality of two alternate angles, the conclusion is the non-tangibility of the two lines that, by the aid of a transversal, form these two alternate angles. It seems perfectly clear that the non-tangibility of these two lines is a sufficient cause of the equality of the two alternate angles, just as the equality of the alternate angles is sufficient to "cause" the lines not to meet. This is so because, as Schopenhauer and Spencer have explained, space-relations are reversible. Notwithstanding these considerations, Durell and Arnold (New Plane Geometry, Page 52) submit a proof of the converse, Euclid I.29.

Let us examine the proof. The first thing we notice is that a strictly logical demonstration is not attempted, but a principle of construction is employed—the ability to make equal angles. This is as if we should demonstrate I.27 by using our ability to draw parallel (non-tangible) lines and showing that the one drawn coincided with the one given. This would be considered a poor demonstration, and a similar proof for I.29 must be considered very weak. The reason so much difficulty is encountered in devising a proof for I.29 is because it *needs no demonstration*, being the converse statement of I.27.

A few remarks are necessary on Euclid's Axiom 12, commonly

known as the parallel postulate. Since it is the converse of I.16, it must be true according to our classification. Consider I.16 in the form—"If two straight lines which meet are cut by a transversal, their alternate angles are unequal." If this be held to apply to a sphere, its converse will also apply. If the conventions of spherical geometry demand that the hypothesis or conclusion be quantified in order to be true, then the converse of the theorem so quantified will be true. Furthermore, it can be shown that I.16 and its converse may be true on a sphere in at least one legitimate sense. Two planes are said to be parallel if they are everywhere equidistant. Therefore, the parallel postulate, I.16, I.27, and I.29 may all be legitimately applied to spherical surfaces if for "straight line" we substitute "circle or arc lying in a plane" and if for "parallel" we substitute "lying in parallel planes." Now it should be clear that if the above theorems do not apply to a sphere, the reason is not to be found in any weakness of the necessary laws of thought but rather in the insistence that on curved surfaces it is not enough for a "straight" line to lie in a plane but that furthermore the planes must interesect at a common point.

Making no pretension to infallibility, mindful of possible defects to be cleared up by more competent hands, and realizing that this short paper can only be suggestive of interesting work in a vast field awaiting enthusiastic laborers, the above logical classification is offered in the hope that it may appeal to mathematicians as a step in the right direction.

RARE PLANT REDISCOVERED IN WESTERN TEXAS CREEK

One of the rarest plant species in the world has been rediscovered in Madera Creek, in the Davis Mountains of western Texas, by Dr. R. A. Studhalter of Texas Technological College here.

The plant is known as Riella, and has been given the English name "ruffle plant," because of its peculiar structure. It consists of a slender stem an inch or so in length, with a thin transparent green wing growing out at one side and curling over its end. The graceful undulations in this green wing caused one American botanist to describe it as "a ruffle standing on end."

The plant has thus far been found in only two states, Texas and North Dakota. It grows only in sheltered canyons, either submerged in shallow water or just above water level. Since water in this western country is not always a certainty in any one place, the plant has been very elusive, disappearing from a known habitat and reappearing suddenly elsewhere.

The ruffle plant belongs to the moss family, and is a member of that subdivision of it known as the liverworts. However, because of its exceedingly peculiar structure and mode of reproduction, it is pretty much a creature apart even among its own botanical kindred.

THE SYSTEMATIC DEVELOPMENT OF LEARNING UNITS IN GENERAL SCIENCE

BY JOHN C. MAYFIELD
University High School, The University of Chicago

(Concluded from the January issue)

EXERCISE 7

"Why is the air indoors in the winter time ordinarily so much less humid than the air outdoors?"

Idea expected in the answer.—Cold air can hold but little water vapor while warm air can hold much more. The cold air with its small amount is heated and its capacity for water vapor very greatly increased. It then has only a small fraction of all it can hold. (No moisture has been taken out! The relatively lower humidity is due to the increased capacity and that in turn is due to the higher temperature, not to expansion.)

Difficulty.—This proved to be the most difficult exercise assigned. Thirty papers were approved at first attempt, forty on the second, sixteen on the third, four pupils made four attempts, two required five trials, and one pupil tried six times.

Difficulties encountered and erroneous explanations offered.—

1. "The moisture is taken out in heating." .... (16)
2. "Expansion of the air makes more room for moisture." .... (10)
3. "The moisture evaporates." .... (7)
4. Some supposed explanation copied from a text .... (7)
5. "The cold dry air coming into the house absorbs the moisture." . (6)
6. Exercise incompletely explained .... (6)
7. Meaningless jumble of statements—"The cold dry air is brought inside and warmed. The dry air absorbs moisture leaving the air indoors dry. The warm air absorbs the moisture making the air less humid." .... (6)
8. "The dry furnace heat absorbs the moisture." .... (3)
9. "Because the outside air is less moist." .... (2)

Comment.—This exercise was found to be based on the most difficult idea of the unit. The typical guesses and erroneous explanations are indicated above. An exercise similar to the substitute given below has been used and succeeds in eliminating many false trials, but some able pupils are forced to give up and ask for help when brought face to face with the real problem. Since relative humidity is so important scientifically and practically, some exercise should present this problem in such a form

as to secure its solution in the minds of the pupils with as few errors as possible.

New exercise.—"On a cold day (14° F.) our heating plant takes air from outdoors which contains all the water vapor it can hold, that is, with a relative humidity of 100%. This same air sent into our classrooms at a temperature of 70° F. has not nearly all the water vapor it can hold, the relative humidity being about 12%. *Yet no moisture has been taken out of the air.* Explain how the relative humidity can be decreased so much without removing moisture from the air. (Suggestion: Be sure you know what *relative humidity* means. Then find out what two quantities might be changed to change the relative humidity. Decide which of the two quantities is changed in this case. Then write your answer.)"

EXERCISE 8

Tell how fresh air is supplied to rooms heated by each of the main types of heating devices."

Nature of response expected.—Fresh air is ordinarily admitted to rooms heated by fireplaces, stoves, and radiators through cracks, opened doors and windows, and window ventilators. Radiators in some buildings, and some fireplaces have special ducts leading from the outside. Hot-air systems ordinarily have a duct leading from the outside to the furnace by which fresh air is brought into the house.

Difficulty.—This exercise was fifth in difficulty. Thirty-five papers were returned for one correction, ten needed two corrections, and one was sent back to the writer three times.

Erroneous responses with frequencies.—

1. Reading of exercise as if it said, "How does each type of heating device supply fresh air to rooms heated by it?" .... (5)
2. The fireplace.
   a. Mentioned only the ventilating fireplace .... (15)
   b. Omitted entirely .... (8)
   c. "Cold air comes down the chimney." .... (5)
   d. "Air goes up the chimney,"—entrance of fresh air not accounted for .... (3)
3. The stove.
   a. Omitted entirely .... (13)
   b. "There is a fresh air duct leading to the stove" .... (7)
   c. Failure to tell where air came in although outlet was accounted for .... (2)
   d. "Comes from the room," i.e., fresh air for the fire was confused with fresh air for the room .... (2)

4. Hot-air system.
   a. Failed to tell how fresh air got from outside . . . . (12)
   b. Told about humidity instead of fresh air . . . . (2)
   c. "It gets fresh air as a stove does." . . . . (2)
   d. Described fan or forced circulation system . . . . (1)
   e. "Gets fresh air through the cold air registers," i.e., those leading from the rooms . . . . (1)
   f. "Moisture comes in with the fresh air." . . . . (1)
   g. "Gets fresh air as a radiator does." . . . . (1)
5. Steam and hot-water systems.
   a. "A hole is cut in the wall back of the radiator." (Compare with B, 3, under Exercise 6.) . . . . (30)
   b. Did not tell how air enters . . . . (3)
   c. Ordinary type not mentioned while some unusual type was described . . . . (4)
   d. Omitted entirely . . . . (2)
   e. Description of a large heating plant given . . . . (2)
   f. Only moisture discussed . . . . (1)
   g. "In hot-water and steam heating systems air is sent to the furnace where it is warmed and sent to the radiators and out into the room." . . . . (1)

Comment.—The method of presenting the problem of the exercise caused some misinterpretation, carelessness resulted in many omissions and errors, and guessing and lack of study led to a number of ridiculous mistakes. With the development of the modern ideas of ventilation this phase of the unit seems not to need so much emphasis. A few minutes of class discussion has been found to be fully as effective and saves an hour or so of time for more valuable work. Other exercises should emphasize the value of correct humidity and circulation in relation to comfort.

SPECIAL EXERCISE

Nature of exercise.—The simplest kind of a diagram of the heating plant which cares for the science classroom was to be made following a visit to the plant. The diagram should have included: inlet for fresh air, tempering coils, fan room, fans, air filters, cool-air chamber, reheating coils, hot-air chamber, duct to classroom, and duct from classroom. All parts were most carefully explained during the excursion and specific suggestions were given on how to start the diagram and connect the different parts. The excursion and diagram were to be completed in a fifty-minute period.

Omissions and errors in the diagrams of 100 pupils.—

1. Reheating coils omitted. (These were not visible and were merely explained.) . . . . (18)
2. Tempering coils at the inlet omitted . . . . (12)
3. Air filters omitted. (These were difficult to see.) . . . . (10)
4. Relations of fans to system incorrectly shown . . . . (2)
5. Diagram badly mixed and useless . . . . (1)

Comment.—This exercise proved to be a very satisfactory device for stimulating the pupils to observe carefully during the excursion and to organize the things they learned. The first three points above indicate parts on which pupils are apt to have hazy ideas. If they are asked to make a list of the parts of the plant during the excursion a large number of omissions is avoided. Lack of skill in making diagrams slows up progress too much unless the teacher gives definite help and instruction at the beginning. It has been found best to have the pupils start their diagrams by representing the classroom with its inlet and outlet before going to the basement. Then when the class returns the pupils are ready to connect the new features with the parts already drawn.

New exercise to be incorporated in the Guide for Study.—"The class will go to the basement of this building to study the heating plant there. After your return make a simple diagram to show how our classroom is heated. Label the different parts."

Tests

Testing aided in revising the tentative analysis and Guide for Study by revealing two points of serious deficiency. Both points were practical phases of the unit which seem essential. One was brought to light by the answers to this question: "If you were building a seven-room house for your own use which method of heating would you install? Why would you choose that instead of one of the others?"

The answer to the first part of the question is considered secondary in importance and the full answer judged on the validity of the reasons given for choosing a particular type of heating system.

Nature of responses to the question (twenty papers).—

Type of system chosen	*Frequency of reasons given*
A. Hot air	1. "Provides fresh air." . . . . . . (3)
	2. "Is cheap." . . . . . . (2)
	3. "Provides humidity." . . . . . . (2)
	4. "Simple." . . . . . . (1)
	5. "Effective." . . . . . . (1)

B. Hot water	1. "Gives better and more heat than others." (?)........................(2)
	2. "Heats more quickly." (?)........(1)
	3. "Has radiation."................(1)
	4. "Is less expensive." (?)..........(1)
	5. "Is easily ventilated." (?)........(1)
C. Steam	1. "Steam carries more heat.".......(4) (There was a class demonstration to show this.)
	2. "Heats quickly."................(2)
	3. "Heats best." (?)................(1)
	4. "Less expensive." (?)............(1)
	5. "Less expensive to operate."......(1)
	6. "Less trouble than hot air." (?)...(1)
	7. "Does not take up much room." (?).(1)
	8. "More efficient..................(1)
	9. "Is effective for large buildings."..(1)
	10. "Better than stove or fireplace."..(1)

The few reasons given per pupil and the doubtful validity of many that were mentioned (indicated in the list by the question marks) show that the pupils did not have a reliable feeling of the strengths and weaknesses of the different types of heating systems. The discovery of this weak spot in the teaching resulted in attempts to remedy it during the reteaching work. The effect of the new emphasis is evident in the answers given to the same question when used in retesting a different group of pupils.

Nature of responses to preceding question used in a retest (seventeen papers).—

Type of system chosen	*Frequency of reasons given*
A. Hot air	1. "Gives best ventilation."........(2)
	2. "Is easy to operate."............(1)
	3. "Provides humidity easily."......(1)
B. Hot water	1. "Cheapest in the end."..........(1)
	2. "Radiators do not get cool quickly." ....(1)
	3. "Operates at low temperatures....(1)
	4. "Is less work." (?)...............(1)
	5. "Is more efficient."..............(1)
	6. "Is quiet."......................(1)
C. Steam	1. "Is clean."......................(3)
	2. "Distributes heat evenly.".......(3)
	3. "Is less expensive."..............(3)
	4. "Steam carries much heat."......(2)
	5. "Doesn't need an expansion tank.".(1)
	6. "Uses all three methods of heat transfer."........................(1)

7. "Is reliable."....................(1)
8. "Uses smaller pipes and radiators.".(1)
9. "Better for large buildings."......(1)
10. "Cheap to install." (?)...........(1)
11. "Carries heat well."..............(1)
12. "Heats rapidly."..................(1)
13. "Cheap to operate.".............(1)
14. "Provides method of humidifying a room." (?).....................(1)

Examination of the list of reasons given in the later test indicates that the pupils had a much clearer notion of the advantageous characteristics of the different systems although some false reasons were still given.

A second significant weakness was uncovered by two questions placed in separate tests: "Why do steam radiators have air vents?" and "Exactly what becomes of the condensed steam from the radiator of a one-pipe steam heating system?" Erroneous answers given to the first by one group of seventeen pupils were as follows:

1. "To prevent explosions."...................................(2)
2. "To let out the steam when there is too much."...............(2)
3. "To let out some of the steam because there are no pipes to carry it back."..(1)
4. "To let out the condensed steam."..........................(1)
5. "To let the heat into the room."...........................(1)
6. "To shut off the steam."..................................(1)

A set of thirty-three answers to the second question contained the following:

1. "It returns to the furnace" (should say that it goes back through the same pipe through which it came up).........................(6)
2. Admitted ignorance..(1)
3. "It goes to the bottom of the radiator."......................(1)
4. "It leaves the radiator, is pushed to the top of the room where it cools and finally leaves by the used air vent."....................(1)
5. "When the valve is turned off it trickles back to the furnace."...(1)

In ten retest papers the following answers to the same question appeared:

1. "It goes out of the valve on the side of the radiator."
2. "The steam condenses in the air."
3. "It stores itself in the radiator."
4. "It is changed to steam by the steam coming up."

From the foregoing answers it would seem that the pupils had, in a large proportion of cases, failed to grasp in any con-

crete way the principal problems in the operation of a steam heating plant using the one-pipe plan.

In order to remedy the weakness in teaching at the points indicated by the tests it seems necessary to include in the analysis of the unit, specific statements of some contributing ideas which were not originally included and which were, therefore, not well taught. The following revision of Element C would seem to be a more satisfactory statement of aims since it includes the desired understandings as important contributing ideas.[1]

C. Special devices are used to promote the transfer of heat from the fire to our rooms.
  1. Several types of such devices are important.
    a. The fireplace uses an open fire to heat a room by direct radiation.
    b. The stove uses convection currents in addition to radiation.
      (1) The fire is enclosed in an iron box with openings to keep it burning.
      (2) Heat conducted through the iron is distributed by convection and radiation.
    c. The hot air furnace depends even more largely on convection.
      (1) The furnace is placed in the basement.
      (2) Air from a cold-air duct is heated within the jacket.
      (3) The warm air is sent through ducts to the rooms by either natural or fan-made convection currents.
    d. The hot-water system depends on convection by water.
      (1) Water is heated between the inner and outer walls of a "boiler."
      (2) Pipes lead currents of heated water through radiators placed in the rooms.
      (3) The heated radiators warm the rooms as stoves would.
      (4) An expansion tank provides for the change in volume of the water as it is heated or cooled.
    e. Steam systems use convection currents caused by the pressure of water changing to steam.
      (1) Water within the boiler walls is heated until it boils.
      (2) The steam is allowed to force its way through pipes to the radiators which condense it and warm the rooms with its heat.
      (3) Thermostatic valves in the radiators let out any air which would keep the steam out of the radiators.
      (4) The water runs back to the boiler through the steam pipe or through a separate return pipe.
  2. Each type of heating plant has advantages and limitations.
    a. The fire in a fireplace is attractive and is easily and quickly set going, but it is limited in heating range and efficiency and the fuel litters up the room.

---

[1] See the first section of this article Vol. XXXII (March, 1932) pp. 250-251.

b. The stove is more efficient, but it, also, lacks cleanliness and warms only a few rooms with poorly distributed heat.
c. Hot-air furnaces heat whole houses, are good ventilators, are flexible, and relatively inexpensive but cannot send their heat long distances nor always distribute it evenly to the rooms.
d. Hot-water systems are expensive to install, slow to heat, and limited in size but give a very economical and even heat which can be readily regulated.
e. Most steam systems are more difficult to regulate since the radiators are either at the temperature of steam or cold, but they heat quickly and the heat can be carried long distances. (Modified steam, or vapor systems overcome some of these limitations.)

3. Combinations of different types of heating systems often prove advantageous.

A new form of Guide for Study is made up on the basis of the results with the tentative form together with the revised unit analysis. As given below the revised Guide for the unit, "Heating and Ventilating Our Buildings," includes revised guide topics, revisions of the tentative exercises or substitute exercises, and new exercises to cover points previously neglected. The new exercises are of course tentative and should be revised after trial, if it seems advisable. It will be noted, too, that no references nor exercises are included for Element A of the analysis so that Section A of the Guide corresponds with Element B, Section B with Element C, and Section C with Element D, respectively.

HEATING AND VENTILATING OUR BUILDINGS[2]

GUIDE FOR STUDY

The very fact that you are here studying science is made possible by man's discovery that he need not be at the mercy of natural weather, but that he might create weather conditions of his own within his shelters. Through the ages since he discovered fire he has been learning better and better how to make nature do his bidding and provide him with comfort. Each generation has learned something new and passed it on. With the knowledge which they had received, the children learned even more. Now we know quite well what the best air conditions are, and not only that they are good for comfort but that they add to our health and working efficiency.

There are many industries, too, in which atmospheric conditions must be kept right or production is slowed up and costs are increased. This is particularly true of printing establishments and newspaper plants. If heat and moisture conditions are not correct the paper shrinks or stretches, static electricity makes the sheets fly apart or stick together, and the inks and inking rollers do not work well.

[2] See the first section of this article, Vol. XXXII (March, 1932) pp. 250-261.

We cannot learn, in a few weeks, all that scientists and engineers know about heating and ventilation. We can, however, learn some of the important scientific principles on which our indoor weather depends and how our more common heating systems use these principles. This knowledge will prove to be of practical value in understanding and using our surroundings, and it will help us to appreciate the progress which man has made and is making toward controlling the world of nature for his own benefit.

A reasonable number of exercises cannot be devised to cover all the important ideas about heating and ventilation. You should, therefore, try to learn as much as possible in addition to what is required by the exercises.

Good material on the unit is to be found in many books not mentioned on this Guide for Study. Tower and Lunt, *The Science of Common Things*, contains directions for a number of simple experiments. See pages 145–218. We have also a large number of pamphlets and clippings which are just as worthwhile as the textbooks and in many cases more up-to-date and understandable. They will be kept on the shelf at the side of the room.

A. *The transfer of heat from place to place.*
   1. Radiation.
   2. Conduction.
   3. Convection.

   References:

   Pieper and Beauchamp, *Everyday Problems in Science*, 56–57,* 176–77, 230–31, 261, 262–68.
   Barber, *First Course in General Science*, 113–22.
   Bowden, *General Science*, 44–56.
   Clement, Collister, and Thurston, *Our Surroundings*, 102–104.
   Hodgdon, *Elementary General Science*, 87–103.
   Hunter and Whitman, *Civic Science in the Home*, 185–86.
   Pamphlet, *Keeping the Home Fires Burning*, 9–10.
   Webb and Didcoct, *Early Steps in Science*, 64–70.
   Wood and Carpenter, *Our Environment*, etc., 233–237.

Exercise 1. Give ten instances in which you have actually noticed the transfer of heat by radiation. Give also ten instances of conduction and ten of convection from your own experience. Try to make the instances somewhat different from each other so that your lists will not be monotonous repetitions. (In case you cannot immediately think of enough cases that you have observed you may postpone the completion of the exercise until you have a chance to look for them in the laboratory and shop, and at home.)

Exercise 2. Explain why fluids (gases and liquids) move in "convection currents" when they are being heated.

B. *The transfer of heat by common heating devices.*
   1. Structure of common heating devices and systems.
      a. Fireplace.

* All references are to page numbers.

b. Stove.
c. Hot-air furnace.
d. Hot-water system.
e. Steam system.

2. How each device applies the methods of heat transfer to its work of heating rooms.
3. Advantages and disadvantages of different heating systems.

References:

Pieper and Beauchamp,* 261, 264–71.
Barber, 120–145.
Bowden, 77–84.
Hodgdon, 104–111.
Hunter and Whitman, 188–198.
Pamphlet, *Keeping the Home Fires Burning*, 11–26.
Webb and Didcoct, 72–75.
Wood and Carpenter, 218–219, 226–243.

Exercise 3. Trace the heat from the fire to the air and objects in a room through each of the devices listed under *B, 1*, above. Name the methods of transfer in each place where they occur. It will be best to write your exercise in the form of a table like the one below. (Remember that radiant heat warms air very little by passing through it.)

The Transfer of Heat from Fire to Room

Step	Method of Transfer
a. Fireplace	
(1)	....
(2)	....
b. Stove	
(1) Fire to iron of stove......	Conduction, radiation, convection
(2) Through iron............	Conduction
(3) From iron to air..........	Conduction
(4) Stove to distant parts of room..................	Convection
(5) Iron directly to objects and walls....................	Radiation
c. Etc., etc.	

Exercise 4. Tell briefly how each of the following devices works and how each aids in the heating of our buildings: air vent in a radiator, expansion tank in a hot-water system, safety valve on a boiler, steam gauge, water gauge, radiator, thermostat, chimney.

Exercise 5. In some brief form (such as a table or outline) state the advantages and disadvantages which you can find or think of for each of the different types of heating devices or systems.

* Titles as in preceding list of references.

Exercise 6. Draw and *label fully* a simple diagram of the heating system used in your home. *On a separate page explain how it works.* Do your best to make your diagram directly from the heating system. In case you are forced to use help from a book give the author credit by writing, "partly from Bowden," "from Hodgdon," etc., under the diagram.

Exercise 7. The class will go to the basement of this building to study the heating plant there. After your return make a simple diagram to show how our classroom is heated. Label the different parts.

C. *The importance of humidity and circulation.*

1. Relation of relative humidity and circulation to cooling of the body.
2. Control of humidity.
3. Methods of ventilation.

References:

Pieper and Beauchamp, 272–76.
Barber, 311–342.
Bowden, 163–168.
Hodgdon, 171–181.
Pamphlet, *Keeping the Home Fires Burning*, 27–30.
Ritchie, *Sanitation and Physiology*, Part II, 178–185.
Webb and Didcoct, 77–84, 552–553.
Wood and Carpenter, 141–147, 456–458.

Exercise 8. On a cold day (14° F.) our heating plant takes air from outdoors which contains all the water vapor it can hold, that is, with a relative humidity of 100%. This same air sent into our classroom at a temperature of 70° F. has not nearly all the water vapor it can hold, the relative humidity being only about 12%. *Yet no moisture has been taken out of the air.* Explain how the relative humidity can be decreased so much without removing moisture from the air. (Suggestion: Be sure you know what *relative humidity* means. Then find out what two factors might be changed to vary the relative humidity. Decide which one of the two was changed in the case described and write your answer accordingly.)

Exercise 9. Explain how the wrong relative humidity may make one feel too cold at one time and too warm at another. Give examples of discomfort to illustrate your explanation. (Suggestion: Look up the effect of relative humidity on the rate of evaporation.)

Exercise 10. Why does circulation make a hot stuffy room more comfortable even though no fresh air is brought in?

Topics for Supplementary Study

Radiation (value, uses, disadvantages, control, etc.).
Convection Currents and Their Importance in Heating.
Convection Currents and Their Significance in Weather.
Conduction and Its Control in Buildings.
Heat Insulation (in buildings and in steam and hot-water lines, kinds of material used, etc.).
Maintaining the Correct Degree of Humidity in Our Buildings (measurement of humidity, various ways of supplying moisture, importance in manufacturing, etc.).

The Regulation of Temperature in Our Science Room.
Experiments with Heat.
Automatic Heat Control Devices.
The Heating and Ventilating System of the University Chapel (or of a theatre, or of a skyscraper, etc.).
Boilers.
Vapor Heating Systems.
Fuels.
The Use of Electric Current for Heating Buildings.

It will be seen that the nature of Exercise 2 has been changed in the revised Guide for Study. Instead of asking the pupils to give evidence for each step of a proof that the warmer parts of fluids are lifted by the cooler parts, they are merely asked to explain why fluids circulate in "convection currents." The change was made to save the pupils' time in the study of the unit. No doubt the earlier form would give worthwhile training but the unit is difficult enough and long enough with the shorter exercise which has been substituted. Exercise 4 was added to make sure the pupils understand the purposes of the commonly-seen accessories of heating systems. Exercise 5 corresponds with the new section of the analysis which has already been stated and justified. Exercise 7, as was explained earlier, did not appear on the first Guide for Study but was part of the regular work of the unit. Exercises 9 and 10 are substitutes for the earlier Exercise 8 and emphasize the comfort factors of humidity and air circulation.

The new Guide is by no means self-teaching. The teacher must be constantly active, providing demonstrations and exhibits, stimulating further reading, and suggesting how pupils may figure things out for themselves. Most of the exercises should be done individually by the pupils. Interest is created, time is saved, and the class has an opportunity for more co-operation and oral work if parts of Exercises 4 and 5 are assigned to committees of pupils. Such committees may report to the class and each pupil write his exercise as a resumé of the reports.

Units developed by steps like those which have been outlined and illustrated in this article can become teaching instruments of increasing efficiency, especially if their development is a cooperative enterprise of a number of sympathetic and well-trained teachers.

LABORATORY STUDIES IN GENETICS

By John P. Wessel and Edward C. Colin
Crane Junior College, Chicago, Illinois

INTRODUCTION

About four years ago in our general course in college zoology, the treatment of genetics was confined to the lectures. As the results were not very encouraging it was thought that a few simple breeding experiments would assist the student to grasp more clearly some of the fundamental principles of genetics. A few experiments demonstrating Mendelian ratios, segregation, random assortment, sex ratios, and sex-linked inheritance were attempted. Judged on the basis of the results obtained in the examinations, the experiments proved highly successful.

It is possible to perform the experiments listed in this paper in only a few hours time spread over a period of about ten days. If the instructor desires to give a minimum amount of time to the experiments, the laboratory instructor should prepare the media, sterilize the cultures, and make the matings before distributing the culture bottles to the students. The students will merely classify, count, and record the progeny. Besides being eye witnesses to certain genetical phenomena, the students also have an opportunity to actually observe the life history of a typical insect.

It was thought that these experiments and especially the accompanying tables would suggest to high school and college teachers some means for overcoming the difficult problem of teaching genetics to beginning students of biology.

The labortory directions that follow are given the students:

* * * * *

Genetics is the study of *heredity* and *variation*. Only experiments demonstrating some of the principles of heredity will be performed; however, if any variations are observed they should be reported immediately to the instructor. The fly as it occurs in nature is known as "type" or "wild"; any hereditary variation from the type is called a *mutation* and the individual a "*mutant*." The common fruit fly, *Drosophila melanogaster*, will be used.

GENERAL DIRECTIONS

a. Preparation of media.—Prepare a medium on which yeast will grow luxuriantly. The larvae and probably the adult flies

feed upon the yeast. The two most widely used media are "banana" and "yellow corn meal."

1. *Banana Medium*

Fifty parts by weight of water.
One part by weight of agar-agar.
Fifty parts by weight of crushed, peeled bananas.

Dissolve agar-agar in water and add bananas to the hot solution. Boil for ten minutes.

2. *Yellow Corn Meal Medium*

2000 cc. of water.
30 grams of agar-agar.
200 grams of yellow corn meal.
150 cc. Brer Rabbit Molasses.
150 cc. Karo Syrup.

Dissolve agar-agar in water and gradually add the corn meal, mixing vigorously so that a homogeneous mixture is obtained. Add molasses and syrup. Allow the mixture to boil until the desired thickness is obtained. This is sufficient medium for about forty, eight ounce bottles.

b. Sterilization.—The bottles in which the matings are to be made must be free of *bacteria* and *molds*. This is accomplished by sterilizing with steam under fifteen pounds pressure for twenty minutes in an *autoclave*. Before placing the bottles in the autoclave a piece of paper toweling about two inches wide and two-thirds the height of the bottle should be placed in each. Now pour the hot medium into the bottles to a depth of about one inch. Do not allow any of the medium to lodge on the necks of the bottles. Use a large funnel, rubber tubing, and clamp. Insert the free end of the tubing into the bottle before releasing the clamp. Insert a plug of non-absorbent cotton in each bottle. The culture bottles are now ready to be sterilized. After they have been sterilized allow them to cool. When they have cooled to room temperature, introduce a few particles of yeast foam. Use a sterilized blade of a knife to dislodge a few particles from the yeast cake. When removing a cotton plug never allow the end which is inserted into the bottle to come in contact with any object; otherwise it may become contaminated and it in turn will contaminate the culture. The culture bottles are now ready for use.

c. Sexes.—Sexes can easily be distinguished with the aid of a hand lens by the size, shape and pigmentation of the abdomen. The abdomen of the female is larger, its tip more pointed, and less pigmented than the male. The male is most certainly distinguished, especially in pale, newly emerged flies by the presence of a brown spot near the tip of the abdomen on the ventral surface, lacking in the female. Consult "Genetics of Drosophila" by Morgan, Bridges, and Sturtevant in volume two of "Bibliographia Genetica," for differences in external genitalia.

BREEDING RECORD

No. 1: Experiment A. *Name*..

MATING: Long-Wing × Long-Wing	SPECIES: D. melanogaster
MALE: Long-Wing (Vv)	FROM: Long-Wing (VV) × Vest.-Wing (vv)
FEMALE: Long-Wing (Vv)	FROM: Long-Wing (VV) × Vest.-Wing (vv)
DATE MATED....................	REMOVAL OF PARENTS..................
FIRST LARVAE................	FIRST ADULTS..............................
FIRST PUPAE....................	

MALES

Characters	Date	No.	Date	No.	Date	No.	Date	No.	Date	No.	Total
Long-Wing											
Vest.-Wing											
								Total Males			

FEMALES

Characters	Date	No.	Date	No.	Date	No.	Date	No.	Date	No.	Total
Long-Wing											
Vest.-Wing											
								Total Females			

OBSERVED TOTAL: Long-Wing........... Vestigial-Wing...........
EXPECTED TOTAL: Long-Wing........... Vestigial-Wing...........
CONCLUSIONS:

1. Explain your sex-ratio results with aid of diagram.
2. Explain the presence of dominant and recessive characters, segregation, and the 3:1 Mendelian ratio with aid of diagram.

BREEDING RECORD

No. 2: Experiment B. *Name*..

MATING: Long-Wing, Gray-Body × Long Wing, Gray-Body	SPECIES: D. melanogaster
MALE: Long-Wing, Gray-Body (VvEe)	FROM: (VVee) × (vvEE)
FEMALE: Long-Wing, Gray-Body (VvEe)	FROM: (VVee) × (vvEE)
DATE MATED:....................	REMOVAL OF PARENTS....................
FIRST LARVAE....................	FIRST ADULTS..................................
FIRST PUPAE........................	

MALES

Characters	Date	No.	Date	No.	Date	No.	Date	No.	Date	No.	Total
Long-Gray											
Long-Ebony											
Vest.-Gray											
Vest.-Ebony											
										Total Males	

FEMALES

Characters	Date	No.	Date	No.	Date	No.	Date	No.	Date	No.	Total
Long-Gray											
Long-Ebony											
Vest.-Gray											
Vest.-Ebony											
										Total Females	

OBSERVED TOTAL:	Long-Gray............	Long-Ebony............
	Vest.-Gray............	Vest.-Ebony............
EXPECTED TOTAL:	Long-Gray............	Long-Ebony............
	Vest.-Gray............	Vest.-Ebony............

CONCLUSION: Discuss the principle of random assortment with aid of diagrams.

d. Procedure.—Place the male and female to be mated in a prepared culture bottle. Eggs should appear in a few days; the fourth or fifth day, the larvae, the seventh or eighth day, the pupae, and the eleventh or twelfth day, the adult flies. When the pupae appear remove the parent flies so that they will not be included in the counting of the offspring. As soon as the adult offspring appear they should be counted. Count the flies every laboratory period over a period of about ten days. The flies can be easily counted and classified by anesthetizing them. Use ether. Apply ether to the cotton plug of a transfer bottle. Allow the flies to crawl into the transfer bottle and then insert the *cotton plug with ether into the transfer bottle.* Invert the culture bottle if necessary and tap it gently so as to force the flies into the transfer bottle. Remove only ten or fifteen at a time. Place

BREEDING RECORD

No. 3: Experiment C. *Name*..

Mating: Red Eye×Red Eye	Species: D. melanogaster
Male: Red Eye (W–)	From: Male (w–)×Female (WW)
Female: Red Eye (Ww)	From: Male (w–)×Female (WW)

Date Mated:....................	Removal of Parents....................
First Larvae....................	First Adults....................................
First Pupae........................	

MALES

Characters	Date	No.	Date	No.	Date	No.	Date	No.	Date	No.	Total
Red-Eye											
White-Eye											
								Total Males			

FEMALES

Characters	Date	No.	Date	No.	Date	No.	Date	No.	Date	No.	Total
Red-Eye											

Observed Total: Red-Eye Females........... Red-Eye Males...........
White-Eye Males...........

Expected Total: Red-Eye Females........... Red-Eye Males...........
White-Eye Males...........

Red-Eye Total: .... White-Eye Total ....

Conclusion: Explain the sex-linked ratio you obtained with aid of diagram.

the anesthetized flies on a sheet of paper and with a camel's hair brush segregate them so that you can conveniently and accurately classify and count them.

If matings of the second filial generation are to be made in any of the following experiments, pupae must be isolated in order to obtain virgin females.

EXPERIMENTS

The students are to work in pairs, or in groups of three or four, to be decided by the instructor. Each member of a group is to make an independent count and classification of the flies, so as to furnish a check on the work of his partner. If there is any disagreement among the members of a group concerning the classification, the instructor should be consulted. Each student will record his own results for each experiment.

a. Experiment showing dominance, segregation, sex-ratio and the 3:1 Mendelian ratio.—The instructor will furnish a male and female of the first filial generation of a cross between a *homozygous long-wing* fly and a *vestigial-wing* fly. Mate these flies and classify their offspring according to sex and wing character. Record the data on "Breeding Record" sheet number one.

b. Experiment showing random assortment.—A male and female of the first filial generation of a cross between a *homozygous long-wing, ebony-body* fly and *homozygous vestigial-wing, gray-body* fly will be furnished by the instructor. Mate these flies and classify their offspring. Record the data on "Breeding Record" sheet number two.

c. Experiment showing sex-linked inheritance.—The instructor will furnish a male and female from the first filial generation of a cross between a *white-eyed male* and *red-eyed female*. Mate these flies and classify their offspring. Record the data on "Breeding Record" sheet number three.

TWO HIGH GERMAN AWARDS GO TO AMERICAN SCIENTISTS

Two American scientists have been honored by high German awards. The gold medal of the Paul Ehrlich Foundation of Germany has been awarded to Dr. Oswald T. Avery of the Hospital of the Rockefeller Institute for Medical Research, New York. Dr. Michael Heidelberger, formerly of the same institution and now of the medical department of the Presbyterian Hospital in New York and associate professor of biochemistry of the College of Physicians and Surgeons, Columbia University, has been awarded the silver medal of the Paul Ehrlich Foundation. The awards were for the Americans' "epoch making chemo-immunological discoveries."

THE ANNUAL CONVENTION OF THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS AT CLEVELAND, OHIO, NOVEMBER 25 AND 26, 1932

The annual Convention of the Central Association of Science and Mathematics Teachers, held at Cleveland, Ohio, Friday and Saturday November 25 and 26 is generally admitted to be one of the very finest, if not the finest convention ever held by the Association. The local arrangements had not been made by a few individuals working without much help from a large number, but, apparently the various agencies in the entire city had coöperated perfectly to make the meeting a great success. Large credit belongs to President F. R. Bemisderfer for complete organization of those school men and women of Cleveland who are vitally interested in the work of the Association so that all possible influence was brought to bear on the business and other powerful agencies of the city to secure their full coöperation which was so abundantly given.

An innovation was made in arranging for practically the entire program under one roof, that of the Hotel Cleveland. Many members were skeptical of this arrangement, at first. However, everyone was won over before the end of the session, for with all the facilities of a great hotel, there was little need for visitors to leave the scene of activity and be subject to the distracting influences of the city.

The convention was preceded as it always is by a meeting of the Board of Directors, General and Sectional Officers on Thanksgiving evening. This important business meeting served to organize the officers and led to a better understanding of what was expected of each one.

General Program

(President F. R. Bemisderfer presiding)

The general program opened at 8:00 A.M. Friday, on the mezzanine floor with the registration. Then at nine o'clock the members entered the Ballroom where a most excellent musical program was presented by the Choral Club of John Adams High School, under the direction of Mr. Thomas Roberts.

This was followed by a most cordial address of welcome by Dr. Robinson G. Jones, Superintendent of the Cleveland Public Schools.

The response for the Association was given by Mr. Glen W. Warner, of Crane Junior College, Chicago, Editor of the Association's Official Journal. His address follows:

Response to the Address of Welcome

On behalf of the Association I accept with most sincere thanks the warm welcome of the Cleveland schools and of the City of Cleveland. For weeks we have been somewhat aware of the careful preparation that has been going on here and all thru the great state of Ohio for this convention but not until this session opened did we begin to realize the effectiveness of that work. Surely there is evidence of splendid team work. The musical feast this morning has started the day right and shows that the Cleveland Schools are at the front in art as well as in science. Mr. Jones, I congratulate you on the excellence of your educational department. I think it is

indicative of splendid leadership. It is impossible for the Association to pay for this bountiful entertainment. Your compensation must come from the satisfaction the educator derives from a contribution that yields educational dividends for the future. We have faith that the work of this Association will be beneficial to the schools in years to come. May I digress just a little to recall the evidence that supports this faith? The history of science instruction for the past thirty years shows that our founders made no mistake when they started an organization that would promote the common progress of a group of interlocking subjects. At the time it seemed to many that little relation existed between some pairs of these subjects; as the years passed, not only has mathematics become more closely interwoven with the progress of physical science, but the biological sciences have become heavily dependent upon the basic principles of mathematics.

The present economic situation is striking hard at the school subjects we represent. Instruction in mathematics cannot make progress by the lecture method; laboratory and field work do not readily adapt themselves to mass production. The value of equipment and the necessity for individual instruction in these subjects makes them vulnerable to the attacks of the educational wrecking crews at work in all parts of the country. This Association must work as never before to hold the ground that has been gained and to insure the progress of scientific education for the next generation. We admit imperfections and our purpose is to eliminate or to reduce these faults by proper reorganization of subject matter from kindergarten to college, by improvement in method and technique, and by encouraging higher professional standards.

This you are helping us to do. Those of us from other cities hope that this convention may bring something of enthusiasm, professional spirit and encouragement to your teaching staff, to the school children and to the citizens of Cleveland. May we all consecrate our lives to the discovery and dissemination of the truths of science, to the conservation of the wonderful bounties the great God of nature has loaned us, and to dispelling the tortures of ignorance, superstition and disease.

Dr. Louis C. Karpinski, Professor of Mathematics in the University of Michigan delivered an inspiring lecture entitled "Linear and Quadratic." This address was published in the January issue of the Journal.

Dr. William E. Wickenden, President of Case School of Applied Science then addressed the Association on the subject of "Cooperation between School and College in maintaining standards."

Following Dr. Wickenden's lecture, tables were brought into the ballroom and luncheon was served by the hotel—a most excellent scheme to hold the group together. Later, the tables were as quickly and easily removed from the room and the stage was set for the lecture of Dr. George W. Crile, of the Cleveland Clinic whose lecture on "The Rôle of Chemistry and Physics in the Living Organism" was a revelation. All will be interested in reading this address which was published in the January issue of the Official Journal.

The members then went to the lecture rooms where the several Sectional programs were held, a review of each of which follows:

Biology Section

The meeting of the Biology Section was called to order in Rooms 27–29 of the Hotel Cleveland at 2:00 P.M. by the Chairman, Dr. William Gould Vinal of the Cleveland School of Education.

He introduced Dr. Bradley M. Patten of the Baldwin Bird Research Laboratory and Associate Professor of Histology and Embryology of the School of Medicine, Western Reserve University. Dr. Patten spoke on "The Beginning of Circulation in the Chick Embryo." He showed a micro-movie showing the most interesting stages in the development of the heart-beat and establishment of circulation in the chick.

Professor Ellis C. Persing of the School of Education, Western Reserve University then spoke on "A Critical Evaluation of Biology Work Books." A discussion of this paper was led by Mrs. Orra Olive Dunham of Collinwood High School.

Dr. Ralph Tyler, Bureau of Educational Research, Ohio State University, Columbus, Ohio spoke on the subject of "Tests in Biology." He pointed out that tests should find what difficulties the student is experiencing and determine the effectiveness of instruction, all of which determines the amount of progress the student is making. He said that changes are not necessarily progress. He insisted that teachers must formulate objectives and then select tests that cover these objectives. Objectives in general are found in the fund of facts, the technical terms, the application of principles, the scientific method and in skill. Tests should show if these objectives are being reached, for a good test should cover the objectives.

Dr. J. Paul Visscher, Professor of Biology, Adelbert College Western Reserve University, Cleveland, spoke on "Biology Stations in Europe." He spoke particularly of the Biological Stations of Naples, Russia, Heidelberg, and Plymouth.

The nominating committee appointed by Dr. Vinal at the beginning of the Section meeting reported at this time and the following officers were duly elected for next year.

Chairman: Joel W. Hadley, Indianapolis, Ind.
Vice-Chairman: Mrs. Orra Olive Dunham, Cleveland, Ohio.
Secretary: Fred R. Platt, Chicago, Ill.

Chemistry Section

The meeting was called to order by the Vice-Chairman, Clyde W. Holt. Vernon S. Culp was appointed acting secretary due to the absence of the secretary.

Dr. Harry N. Holmes of Oberlin College presented the first paper on the subject, "The Application of Colloid Chemistry to Medical Research." He first reviewed the meaning of colloid particles, the range of their sizes, and their relation to sub-microcrystalline particles that form a true solution. He showed how to determine if a substance is a colloid by the use of certain membranes, such as cellulose sausage skins or a dialysing membrane which can be made by pouring collodion over a test tube and removing the film formed in warm water. If the alcohol is washed out of the collodion with benzol, the benzol takes the place of the alcohol. This results in a membrane through which molecules truly dissolved in benzol can pass, but which does not permit the passage of water. Cell walls and various membranes in plants and animals seem to show selective diffusability similar to that of various artificial membranes. There also seems to be selective and preferential adsorption. Different types of cells absorb the necessary

materials from the blood. Since cell walls are so permeable, why do materials not go both ways? It is possible that there is also preferential adsorption within the cell. Among the surface phenomena of colloid particles we find (1) attraction, (2) interfacial tensions, (3) electrical charges (4) and liquids attracted to solids or swelling. Bacteria are arranged around many particles. These are non-filterable if as small as 30 or 40 millionth millimeter in diameter. Bacteria also have electrical charges at their interfaces,—a characteristic of colloid particles. Bacteria, being negative, can be clumped by the opposite charge. The body is composed of a high percentage of water. Life processes are related to the water holding power of tissues, such as the water holding power of the proteins. The blood contains protective colloids. A change in them causes disease. Thus certain diseases can be detected by blood tests. Selective adsorption and desorption principles are used in the isolation of certain vitamins. In the use of aluminum sulfate for water purification, the aluminum hydroxide formed has an enormous selective attraction for bacteria. Thus the chemistry of colloids is involved in many bodily functions, in the extraction and purification of medicinals, as well as their functioning when used in relation to health and disease.

The second paper was a discussion of "Pandemic Chemistry" by G. T. Franklin of Lane Technical High School, Chicago, Ill. Pandemic Chemistry tells us a story about chemistry but does not tell us much chemistry. It would exclude most of what we are now doing in the class room and laboratory. Pandemic Chemistry must also be defined in relation to the pupil. What is pandemic for the college student may be just the opposite for the high school student due to his lesser knowledge of the subject. There is not much chemistry unless we can handle the simple tools. It is supposed to socialize chemistry. It is again learning about its social relations without an understanding of the relations themselves. In the study of baking powders, pandemic chemistry would include the historical approach, their industrial and economic aspects, and how they are used. The non-pandemic approach is in the laboratory. This uses a broad view of previous work on acids and salts, their solubility, their activity in solution, and especially the action of acids or substances with acid properties on carbonates in particular. It requires laboratory tests of the properties of the tartrates, phosphates and sulphates used in the powders, leading to a reason for their use. Particularly must it indicate why sodium hydrogen carbonate is used instead of sodium carbonate. The pupil learns by direct experiment the purpose of starch in the powder, the effect of heat in baking on the material and the purpose of the acid ingredient. In the manufacture of pig iron the speaker also brought out a similar relation between the pandemic and laboratory approach the latter answering not only "what" but also "why." Also the functioning of various materials and their impurities can be followed through the blast furnace with its various degrees of heat,—most of it illustrated with simple reactions. The paper indicated a decided preference for non-pandemic chemistry. The speaker considered it of much more value to develop a few fundamental principles which are concerned in many of the subjects treated than to present a maze of merely descriptive material.

The chairman appointed the following nominating committee: C. L. Anderson, Chairman, Charles Randolph, A. P. Minsart.

The following officers were proposed for the coming year and unanimously elected:

Chairman, Clyde W. Holt, East Technical High School, Cleveland, Ohio.

Vice-Chairman, R. E. Davis, Lane Technical High School, Chicago, Ill.

Secretary, M. J. W. Phillips, West Allis High School, West Allis, Wis.

VERNON S. CULP, *Acting Secretary*

GENERAL SCIENCE SECTION

The General Science Section meeting of the thirty-second annual convention of the Central Association of Science and Mathematics Teachers was held in the Bronze Room of the Hotel Cleveland. The meeting was opened at 2:30 P.M. by Ira C. Davis, Chairman. David Dietz, Science editor of the Scripps-Howard newspapers discussed "Public Interest in General Science." His investigations have shown that more newspaper readers are interested in Astronomy than in any other branch of science. It was pointed out that this tendency may be explained by the fact that astronomy is a highly imaginative subject which provides stimulation far afield from the usual cares of life. News of the most recent developments in the field of radio is welcomed by a great majority of the Science Editor's readers. It seems likely that this is due to the fact that during the earlier periods of the development of radio in the home many thousands of people of all classes were obliged to build their receiving sets.

Dr. Morris Meister of the New York Teacher Training College presented slides which showed demonstration techniques found successful in teaching certain units of General Science. Dr. Meister presented his slide material by means of the Didactoscope. The Didactoscope is an instrument for the projection of all kinds of still pictures; glass lantern slides, film slides, microscope slides, post cards, and other opaque objects. It is small, extremely compact, portable and contains within itself all the attachments needed to adapt it to its various purposes.

William L. Connor, Director of Research in the Cleveland Public Schools, discussed "Cleveland's Research Program in General Science." Mr. Connor pointed out that the three year General Science program in use in the Cleveland Junior High Schools has been developed over a period of five years, and is based on previously conducted experimental studies which served to determine the health needs and science interests of pupils in these three grades. All units in this course of study have been taught by experienced teachers and revised one or more times in the light of experience.

Miss Alma Thomas, chairman of the nominating committee, reported the following sectional officers for the next year and they were elected:

Chairman, Paul G. Edwards, Supervisor of Science, Chicago, Ill.

Vice-Chairman Nathan A. Neal, East Technical High School, Cleveland, Ohio.

Secretary, Leonard Johnson, Roosevelt Junior High School, Milwaukee, Wis.

NATHAN A. NEAL, *Secretary*

GEOGRAPHY SECTION

The Geography Section of the Central Association of Science and Mathematics Teachers met at 2:30 P.M. on November 25th in the Hotel Cleveland under the leadership of Miss Villa B. Smith of Western Reserve University, Cleveland, Ohio.

A program of rare interest and professional stimulus was presented. Major Clyde H. Butler, Aerial Surveys, Inc., of Cleveland spoke on "The

Value of Aerial Photographs in Teaching Geography." He explained most interestingly, and showed slides to illustrate, not only how aerial photographs are taken, but also how the films are cut and fitted after developing and finally rephotographed onto the negative from which final prints are made. Slides of both the old type of sketch map and the aerial photographs from the same areas were shown to illustrate the greatly enhanced teaching value of the aerial photographs. The usefulness of aerial pictures both in presenting Economic Geography and Physiography were illustrated by a wonderful series of slides showing changing shore lines, projects of flood control along the lower Mississippi River, types of islands, industrial plants, growth of cities, transportation developments, citrus groves, and many other interesting features. The many enthusiasts over the possibilities of these aerial photographs for teaching work were assured by Major Butler that sets of slides selected to suit individual needs could be procured at very modest prices.

Mr. Ralph Wensinger, Cleveland Air Service, Inc., presented "New Phases of Weather Observation in Connection With Air Transportation." Cleveland is one of five cities in the U. S. where weather observations in the upper air are made by daily flights. This policy was initiated a year ago and Mr. Wensinger undertook the task of making the daily flights. Although a man is not supposed to be physically able to do such flying oftener than one day in three, Mr. Wensinger made 364 out of a possible 365 flights in the year just past. The flight is made at five A.M., Eastern Standard Time each morning, meaning that for seven months of the year it is night work and the plane has to be guided by signals alone. The plane carried a weather instrument suspended on shock absorbers. This instrument records temperature, air pressure, and the humidity conditions of the air during the entire flight, making it possible for the Weather Bureau to predict more accurately conditions below the clouds as well as upper air conditions which are exceedingly valuable in connection with air transportation. Mr. Wensinger told in his delightfully colorful style many of the perils, as well as interesting incidents, encountered on these flights which are made under all sorts of weather conditions. He also suggested some of the remarkable physical reactions experienced due to the great changes of air pressure and temperature. Mr. Wensinger closed his part of the program by showing a reel of motion pictures of one of his flights so that the audience might share some of the thrills of his wonderful air exploits.

The Geography Section feels especially indebted to these pioneers for giving it an adventure into new fields. Such pioneering adventures are an inspiring privilege.

The following officers were chosen for the ensuing year:

Chairman: Edna E. Eisen, Steuben Junior High School, Milwaukee, Wis.

Vice-Chairman: Mrs. Viva Dutton Martin, Arsenal Technical High School, Indianapolis, Indiana.

Secretary: Leonard Schneider, John Hay High School, Cleveland, O.

VIVA DUTTON MARTIN, *Secretary*

MATHEMATICS SECTION

The mathematics section of the Central Association of Science and Mathematics Teachers met Friday afternoon Nov. 25, 1932 in the Empire Room of Hotel Cleveland, Cleveland, Ohio. The president, Mr. W. H. Carnahan of Shortridge High School, Indianapolis, presided. The following were appointed on the nominating committee: Mr. J. Russell McDonald

of Morton High School, Cicero, Ill., Mrs. Chas. E. Scott of East Technical High School, Cleveland, Ohio, Miss Emilie Scheel of Detroit, Mich.

Miss Edith Sechrist of East Technical High School, Cleveland gave a very able presentation of "Using the Unit Plan in Plane Geometry and Measuring its Results." She described the method used in East Technical High in which the work in plane geometry is divided into units, with A, B, and C assignments for each unit which each pupil may handle at his own speed. Copies of some of the objective tests given to cover these units were given those present.

Prof. Louis Karpinski of Ann Arbor spoke on "The Unity of Algebra and Geometry." Some illustrations of parallel ideas in the two subjects cited were the geometric picture of an irrational number, the geometric picture of imaginary numbers with regular polygons which result from such equations as $x^3-1=0$, $x^5-1=0$, the geometric figure for the product of two binomials, the geometric figure for the summation of the series a, ar, ar^2 ——, and the geometric figure for solving a quadratic equation by completing the square.

The third speaker of the afternoon was Mr. Joseph A. Nyberg of Hyde Park High School, Chicago, Ill., who spoke on "Economy of Effort in Teaching." His three main points were, economize in effort by paying little attention to home work, by having much oral work in class, and by devising schemes to get the pupil to use the text intelligently.

Mr. Loomis, compiler of a book on two hundred ways to prove the Pythagorean theorem, was introduced.

The report of the nominating committee, submitted by Mr. McDonald, was as follows: For Chairman, Maurice L. Hartung of Madison, Wisconsin, for Vice-Chairman, DeWitt C. Petty of Chicago, for Secretary, Miss Edith Sechrist of Cleveland.

It was moved, seconded, and carried that the report be adopted.

M. ESTELLE NASH, *Secretary*

PHYSICS SECTION

The Physics Section of the Central Association of Science and Mathematics Teachers met in Room 26 of the Hotel Cleveland, Friday, Nov. 25, 1932 at 2:00 P.M., the Chairman, Mr. Charles A. Marple, presiding. In the absence of the secretary, Mr. D. L. Barr, of Mt. Pulaski, Illinois, Mr. B. F. Saulsbury, of Lincoln High School, Cleveland, acted as secretary, pro-tem. The following interesting program was provided:

"Radio in High School" by G. B. Hamman, East Technical High School, Cleveland, Ohio.

"Some Interesting Apparatus From England and Germany" by Dr. N. Henry Black, Harvard University.

After each discussion questions were asked and answered showing the interest with which the speakers were received. Many helpful suggestions were made by each of the speakers. The experiences of Professor Black in his portrayal of school life and the methods used in science work in Germany and England were particularly interesting to the large group attending this meeting.

The following officers were elected for the coming year:

Chairman: Elmer E. Burns, Austin High School, Chicago, Ill.

Vice-Chairman: J. R. Towne, Marshall High School, Minneapolis, Minn.

Secretary: F. M. Carl, Collinwood High School, Cleveland, Ohio.

B. F. SAULSBURY, *Acting Secretary*

Innovation for Elementary Science Teachers

This group, which was on the following day formally made a Section of the Association by the Constitutional change made at the Annual Business Meeting, met in the Rose Room of the Hotel Cleveland on Friday afternoon.

The meeting was called to order by Professor Ellis C. Persing, of Western Reserve University, the Chairman, at 2:00 P.M.

A most interesting and helpful program was presented consisting of three papers as follows.

"The Content and the Point of View," by Dr. Otis W. Caldwell of Columbia University, New York.

"The Significance of Science to the Pupil in Elementary School," by Mary Melrose, supervisor of Elementary Science, Cleveland Public Schools.

"The Place of Science in the Elementary School," by Dr. Gerald S. Craig, Assistant Professor of Natural Science, Teachers College, Columbia University.

Enthusiastic discussion followed each paper.

The following officers were elected:

Chairman: Ellis C. Persing, Western Reserve University, Cleveland.

Vice-Chairman: Bertha M. Parker, The University of Chicago Elementary School, Chicago.

Secretary: Florence Billig, Detroit Teachers College, Detroit, Michigan.

The Reception

At five o'clock on Friday afternoon, following the Sectional Meetings, the Annual Reception was held in the Tower Room of the Hotel Cleveland. A number of the Past-Presidents of the Association were present and acted as hosts for the occasion under the leadership of Dr. Otis W. Caldwell. This meeting brought out clearly the fine feeling of comradship and good will which exists between the members of this Association and which each finds to be a constant inspiration and help in his work.

The Banquet

The Annual Banquet was, as it always is, one of the finest social events of the convention. It was held in the Ballroom of the Hotel Cleveland at 6:30 P.M. Friday. An interesting special entertainment was provided under the direction of Mr. Dwight W. Lott, of the John Adams High School, Cleveland. The evening lecture was blended with the banquet and Dr. M. Luckiesh, Director of the Lighting Research Laboratory of the General Electric Company, Nela Park, Cleveland, gave the address of the evening, speaking on the subject "Let There Be Light." Portions of his lecture were accompanied by a most remarkable display of colored light which played upon a screen, the effect being produced by a secret process. His lecture was an exposition of the scientific method used in research.

ANNUAL BUSINESS MEETING

The Annual Business meeting was called to order by Dr. Charles A. Stone, vice-president, at 8:30 A.M. Saturday morning, Nov. 26, 1932 and he presided during the early part of the meeting until the president, Mr. Bemisderfer, arrived.

Mr. G. T. Franklin gave a verbal report of the membership committee commenting favorably upon the cooperation of the members in the various states and upon their success in spite of the depression.

Mr. James H. Smith read the report of the Necrology Committee. The entire report follows at the close of these minutes.

The report of the Resolutions Committee of which Mr. G. A. Bowden was chairman was read by Mr. Walter H. Carnahan, a member of the committee. The entire report follows at the close of these minutes.

At this time President Bemisderfer took the chair and called for the report of the nominating committee which was read by the chairman, Miss Ada Weckel, the committee proposing the following officers:

For President: Charles A. Stone (M) University of Chicago, Chicago, Ill.

For Vice-President: E. O. Bower (P) East Technical High School, Cleveland, Ohio.

For Members of Board of Directors, terms to expire in 1935:

Villa B. Smith (G) Cleveland School of Education, Cleveland, Chio.

W. H. Carnahan (M) Shortridge High School, Indianapolis, Ind.

Ira C. Davis (C. & G. S.) University School Madison, Wis.

Jerome Isenbarger (B) Crane Junior College, Chicago, Ill.

Mr. Franklin T. Jones moved, and it was seconded and carried that the report of the Nominating Committee be accepted and the proposed officers unanimously elected.

Dr. Charles A. Stone was then presented as the new president and spoke briefly in accepting the duties of the presidency.

The report of the Conservation Committee was read by Mr. Fred Schriever, of Milwaukee, the entire report following at the close of these minutes.

Mr. Warner suggested that the Conservation Committee look into the matter of using worn out or unprofitable farm lands.

The report of the Auditing Committee was given by the chairman, Mr. O. C. Hursch.

The report of the Research Committee was presented by Mr. Bemisderfer and is printed later in this report.

Mr. Turton moved that the constitution be amended to make the retiring president an Ex-Officio member of the Board of Directors for one year. This was seconded and carried and steps will be taken to make that provision legally a part of the constitution.

The question of the constitutional authority for organization of a new Elementary Science Section was taken up and discussed.

Mr. Warner stated that the amendment organizing the Elementary Science Section could be voted on at this meeting since the proposal had been published in two editions of the Journal and he moved, and it was seconded and carried that the amendment as printed should become a part of the constitution.

The amendment past is as follows: In Article V, Section 4, insert the words "Elementary Science" following the word "Chemistry."

The amended section now reads as follows:

"*Section 4. Professional Sections:* The association shall be divided into sections as follows: Biology, Chemistry, Elementary Science, General Science, Geography, Mathematics and Physics. Each section shall be composed of members of the Association who are especially interested in the subject of that section. The organization and activities of the sections may be amended from time to time by the Board of Directors. Unless otherwise provided by the Board of Directors, each section shall elect its own Chairman, Vice-Chairman and Secretary."

Report of the Necrology Committee

Your committee records upon the honor roll of our dead the following names:

Dr. C. I. Palmer, professor at Armour Institute of Technology, Chicago, Ill.

Dr. L. H. Pennywell, professor at the University of Iowa.

Mr. Ralph M. Sprague, head of the mathematics department of Libby High School, Toledo, Ohio.

The following note of appreciation is by Florence A. Gates of the science department of Libby High School:

"Mr. Sprague was head of the Mathematics department of Libby High School, Toledo, Ohio. A resume of his life shows a firm belief in education which led him, at the age of forty, to complete his high school credits for graduation at Ypsilanti, Mich. Following this, he went to the University of the City of Toledo from which he secured both Bachelor's and Master's degrees. Mr. Sprague had a keen sympathy for young people's problems and many a citizen owes his success to his contact with Mr. Sprague in Woodward and Libby High Schools."

Christian A. Pettersen, Asst. Principal of Schurz High School Chicago, Ill. and Principal of Schurz Accredited Evening High School. For many years he was a member of the Association, working in the Mathematics Section. Mr. Pettersen was a great organizer and an executive of a high order. His judgment was usually proved to be correct. He was fair to all. He was beloved by all who knew him and especially by those who knew him best.

S. M. Turrill, Crane Technical High School, Chicago Ill.

Dr. Ulysses S. Grant, Head professor of Geology, Northwestern University. Dr. Grant was an active member of many associations, chiefly scientific. In our Association he was active in Earth Science and Geography Section. He was a profound scientist, a ripe scholar, an inspiring teacher, and a wonderful man.

In respect and honor for each and all of these, our fellow members, we stand and bow our heads in reverence.

Respectfully submitted

James H. Smith, *Chairman*
Warren Hawthorne
W. F. Roecker

Report of the Resolutions Committee

It is highly fitting at this time that the members of the Central Association of Science and Mathematics Teachers here assembled give recognition of their appreciation of the untiring efforts and interest of those who have been intrusted with the promotion of the continued success of this organization given to the enrichment and stimulation of all that is potential in the American educational system.

Therefore, be it resolved that the members of this organization give unqualified expression of gratitude:

First, To President F. R. Bemisderfer and to his co-laborers for the instigation and successful promotion of this meeting; a meeting that proclaims anew all that is traditionally worthy of this unique organization, a meeting that sets new and worthy standards of interest and profit.

Second, To the teachers of the Cleveland Schools for their generous hospitality.

Third, To the merchants of Cleveland who, though they had little to sell that would be of immediate interest to those assembled in this convention, gave financial aid toward publication of the yearbook.

Fourth, To the Nickel Plate Railroad for the low rates to those attending this meeting.

Fifth, To the editor of School Science and Mathematics and his staff for collecting, compiling and publishing timely educational articles for the advancement of the interests of the profession.

Sixth, To the Cleveland Chamber of Commerce for its active interest in the success of this convention.

Seventh, To the Hotel Cleveland for the splendid room and service accommodations during the convention.

Eighth, To the speakers, musicians and entertainers who contributed so generously to the pleasure of those in attendance.

G. A. Bowden, *Chairman*
Walter Carnahan
Martha Hildebrandt

Report of the Conservation Committee

This committee was appointed in response to a resolution passed by the Association November 29, 1930.

I. Activities of the Committee

1. The Committee has urged that speakers on conservation topics be secured at sectional meetings of the Central Association and at state teacher's conventions. Speakers were secured at some sections.

2. The Committee has corresponded with teachers of different subjects with a view to finding out what is being done or may be done in teaching conservation. A fair amount of success may be reported. It has been the purpose of the Committee to keep at these activities steadily, without undue haste or aggressiveness. Progress should be steady rather than fast.

3. In order to gain a somewhat better understanding of how teachers might treat subjects from the conservation point of view rather than to teach conservation as a separate subject, letters containing a sheet of instructions and 5 return postal cards were sent to 30 instructors in various fields of Science, History, English, Art, and Trade Subjects in the state of Wisconsin. Some twenty instructors cooperated in this undertaking and

from the answers it seems that conservation has been brought into such various subjects as fire prevention in General Science, plant reproduction in biology, saving of rags and the conservation of forest products used in printer's ink in a print shop course, and discussions on trees in oral English. Exercises in arithmetic and grammar may be framed to present effective conservation education, and in this field Thoreau, Emerson, Burroughs, and Mills present endless opportunity in literature classes.

Related investigation has been made by the Wisconsin Association for Conservation Education, under the direction of H. J. Parmley of Milwaukee, and also by the Phi Delta Kappa Fraternity as explained in an article appearing in the "The Phi Delta Kappan," August, 1932 entitled an "Investigation into the Status of Instruction in Conservation" by W. O. Nagel.

II. Summary of the Report of November 25, 1931 is still a basis for our work

The committee feels that there still is a great amount of work to be done and that the work as outlined in the Report of November 25, 1931 has scarcely begun to be accomplished.

A. The Conclusions

(1) That conservation education work needs better organization, so that the efforts of various groups do not needlessly overlap, or fall short of the mark.

(2) That conservation need not be taught as a separate study in the curriculum.

(3) That for some time at least conservation may best be taught in correlation with other subjects, such as Biology, General Science and the Social Sciences. Certain phases of English, Economics, Chemistry, Physics, Civics and Geography afford excellent opportunities for presenting the essential truths.

B. Recommendations for further study

(1) Reference lists of books, publications and manuals to help the teacher should be provided. Lists may be unified.

(2) Textbook publishers may be approached to give subjects a conservation slant. The importance of the subject warrants such treatment.

(3) The secondary school course under preparation should provide for conservation education at least in correlation with other subjects.

(4) Conservation credits might be required for a teacher's certificate, at least in the field of Science.

(5) Sectional meetings of our Central Association and of state teachers' associations should be urged to have conservation speakers at opportune times.

(6) All schools should avail themselves more of the aid of Federal and State conservation agencies, and of local agencies as well, in extracurricular activities related to conservation.

C. Recommendations for immediate action

(1) That a conservation committee or committees continue the study of this subject for another year.

(2) However, that the present committee cease to exist after February 1, 1933 and that a new committee be appointed before the latter date. The new committee should consist of five members, representing the various states in which our Association is distinctly active. At the earliest opportunity all the states which lie within the sphere of action of our Association should have representation on the committee either by a member or by a representative.

(3) That the sectional meeting of our Association and of our respective teachers' associations secure conservation speakers whenever possible.

(4) That the presentation of the subject matter of Biology and General Science be made from the viewpoint of conservation whenever possible.

(5) That all schools which are in position to do so should provide outdoor laboratory work in conservation.

(6) That a plan be devised for the correlation of conservation with other sciences as well as with the Social Sciences and English.

(7) That courses in Education, in Science, in Geography and in Social Science as given in Universities and Teacher's colleges be enriched by units and theses on conservation and that the establishing and endowment of professorships in conservation be encouraged.

FRED SCHRIEVER, *Chairman*
P. K. HOUDEK
O. D. FRANK
J. L. COOPRIDER
R. B. SIMON

GENERAL STATEMENT CONCERNING THE COMMITTEE ON RESEARCH

The Association has appointed a committee on research. This is recognition of the need of a further attack on some of the problems in the teaching of science and mathematics. Much has been done in the last ten years by individual members of the Association, but if we are not mistaken, no continuous and concerted effort has been directed toward the purely professional problems of science teaching. An examination of the volumes of School Science and Mathematics for the period from 1921 to 1931, inclusive, gives evidence, however, of much individual interest and effort in the solution of some of these teaching problems. Indeed, a committee on reorganization was active during the first part of this period. This committee and its subcommittees made some helpful suggestions and solicited others from members of the Association. As far as the records in School Science and Mathematics reveal, the activity of the committee seems to have ended with its first report. The work of this committee was apparently stimulated by the earlier report of the committee on science of the National Commission on the Reorganization of Secondary Educa-

tion. The deliberations of that commission, represented in its general report and the reports of its various committees, set the whole country talking about reorganization.

Curiously enough, there is not much evidence that secondary school courses in science have been greatly transformed by the use of the guide-posts set up by the national commission. We talk about the Seven Cardinal Principles of Education, we seem to believe in them, but our courses continue to be very much the same as they were. As one of our members has suggested, although we believe in the practical tenets of the cardinal principles, we hesitate to follow their dictates, fearing that our courses will become superficial. A course in chemistry or in physics which cannot be called thorough by the subject-matter specialist is severely critiziced by the lover of academic scholarship. It is this type of criticism which still makes light of our very good courses in general science. This is carried to the extent of refusal of preparatory school credit for general science for entrance requirements in some of our colleges and universities. The belief that science cannot be learned unless it is presented in the logical form provided by the subject-matter specialist still persists in some quarters. In spite of all the available statistical evidence to show that this is an erroneous assumption, these believers in the traditional subject-matter organization in science may criticize with poor grace some of our less learned people who tenaciously cling to certain other unfounded beliefs, such as superstitions, for example.

We wish to pay our respects to the many fellow-members who have written for School Science and Mathematics presenting the evidences from long experience, and in numerous cases from controlled experiments, showing that conventional courses do not fully meet the needs of pupils, and that reorganized courses have often proved measurably superior. The past volumes of our journal contain scores of articles indicating much thought on the problems of reorganization. The journal is a veritable mine of information and ideas in this field. If one is ever inclined to question the value of the time and labor spent in printing and distributing such a journal, he will be reassured by scanning the last ten volumes of School Science and Mathematics. We hereby detour to do homage to the editorial and managerial staff of our official journal.

Statements from these last ten volumes which might be quoted indefinitely show that individual members of our Association have been greatly concerned about reorganization. With a consensus of opinion, represented by many journal articles with hundreds of significant statements, the underlying sentiment of the members of our Association in favor of reorganization cannot be doubted. The difficulties arise when we begin the task of reorganization. We fear to drop out any of our old and respected content. We add new content revealed by recent discovery and invention, and thus succeed only in making our courses more unmanageable. This may be noted from the increasing size of our recent text books, particularly noticeable in physics. When one reflects on the necessity of encouraging pupil

supplementary reference reading, or stimulating initiative and self-reliance in individual pupil project work, and couples this with the relatively unsatisfactory achievement records on textbook content, he is forced to the conclusion that something should be done about it soon.

The committee is considering plans for some constructive work. It does not expect to solve many problems over night but it has hopes of accomplishing some definite objectives if a continuous effort is brought to play and encouraged by the Association. There is no question that there are solutions if only the problems are identified and we desire the solutions strongly enough. We solicit any suggestions which individual members may care to make. We hope that none may be silent if they have any ideas on the subject. We formally invite teachers to plan variations in content or in method with their classes, and by experimental trial, test and evaluate the proposed solutions. Publicity and due credit will be given any reports submitted. This is recognized as one function of the committee.

Teachers can and must solve these problems. Otherwise they will never be solved. One very modest committee member wrote that her little teaching units were so insignificant when compared with those she had seen that she hesitated to even mention them. Such modesty must be overcome. The units which she uses are samples of everyday school practice of progressive teachers. They have been found to work. Oftentimes the more complicated units of which she speaks do not prove so practicable. Some of these so-called simple units may give us answers to our problems.

Committee members expect to engage in some projects of a research nature, and we hope to be able to report some progress at the next annual meeting. The point of attack will center at first on course content. The various science and mathematics courses are represented on the committee. We hope to add other members as time goes on.

A. W. HURD, *Chairman*

SATURDAY MORNING PROGRAM

At 9:30 Saturday morning, following the Annual Business Meeting, President Bemisderfer opened the program in the Ballroom by introducing Dr. Otis W. Caldwell, Director of the School of Experimentation, Teachers College, Columbia University, New York. Dr. Caldwell is a past president of this Association and has been active in its affairs from the time of its organization. Dr. Caldwell referred to the ideals and ideas of the founders of the Association who met as friends and recommended that the present members of each group of our organization meet in this way now. He commended highly the local committee and praised the Cleveland Convention.

His lecture on "Science—Truth or Propaganda" was an earnest appeal for Science and Truth to prevail rather than the results of unfounded philosophy or plain sentiment or superstition.

President Bemisderfer presented to the audience Mr. James H. Smith of Chicago who was president of the Association at the time it last met in Cleveland and he spoke briefly to the group.

The address of the Honorable Newton D. Baker which followed was one

of the high lights of the Convention. He spoke on the subject, "Complete Education." He spoke against too early specialization and in favor of general cultural training. He proposed that educated people show complete hospitality to the truth. He advised every young man to take a college education if he is really interested in life. He stated that an educated man should be able to keep his judgment in suspense until he knows the facts, an accomplishment which required mental discipline. He dwelt on the question of what should be the irreducible content of a liberal education before one begins to specialize on the particular problems of making a living. He insisted that there must be a community among scholars and hence that there must be some definition of a general education, and that the success of the British government has been due to the fact that it is controlled by an educated class, that its leaders are educated and do not play politics with fundamental questions. He made a plea that our moral advance in America should keep abreast with scientific advance. He criticised higher education in that it failed to give the common body of knowledge which makes us sympathetic with each other. He stated that if America is to achieve greater things it will result from teachers who are greater than their specialty, who approach problems with tolerance and understanding. Thus, he believes that teachers should get ready for this leadership that will make of America a potent moral force supported by Scientific Knowledge.

Following Mr. Baker's lecture Professor W. W. Hart of the University of Wisconsin spoke in a most interesting manner on "The Mathematics Section in Retrospect and Prospect."

After making his farewell speech to the Association as its president Mr. Bemisderfer announced the field trips to the General Electric Company's Nela Park laboratories and to the Rayon plants which the members enjoyed on Saturday afternoon.

Meeting of Board of Directors Saturday Afternoon

At the meeting of the Board of Directors on Saturday afternoon remaining items of business were transacted and Walter G. Gingery, of Washington High School, Indianapolis, and Miss Katharine Ulrich, of Oak Park High School, Oak Park, Illinois, were re-elected as members of the Executive Committee, and Ross B. Wynne, of Crane Junior College, Chicago, Illinois, was re-elected secretary of the Association.

Consolidated Report Respectfully Submitted

Ross B. Wynne
Secretary of the Association

NEW AND LARGER QUARTERS OCCUPIED BY CLAY-ADAMS COMPANY

The Clay-Adams Company is now located in new and larger quarters at 25 East 26th Street, New York (corner of Madison Avenue) with an entrance also at 20 East 27th Street, where they are prepared to render even better and faster service in providing for your needs. The display room shows in a comprehensive manner a complete line of models, specimens preparations slides, charts etc. for Visual Education in Botany, Physiology, Anatomy, Zoology, Embryology, etc.

The collection in the museum is under the direction of L. Alfred Mannhardt, formerly Associate Professor of Biology at New York University, and is open during business hours daily.

SOME CONSIDERATIONS OF METHOD IN NATURE STUDY

By Walter Elwood

Supervisor of Nature Study, Amsterdam, New York

I. THE TEXTBOOK

Our book will be nature itself, the nearby wonderful world of living things, where we shall find

> ". . . tongues in trees, books in running brooks,
> Sermons in stones, and good in everything."

Printed books are, in nature study, only sources to which we turn, not being specialists, to fill in the gaps in our own observation. They are at their best guide-books only. The teacher-guide is the one who needs them most.

II. THE LESSON

Our lesson will be the thing itself, whether plant or animal, the thing we have been observing or are still observing, keeping in mind always that nature is a going concern and all of its children are continually up and about their business.

III. THE LESSON PERIOD

1. Ten minutes or more, made brisk and lively.
2. Informal.
3. Not a recitation but a discussion time in which you do a minimum of telling, giving only such facts as are needed to excite interest or imparting such information as is needed to round out the children's observation; the boys and girls ask questions; you draw out their observations and interpretations; you leave them with some further questions to answer, some interesting problems as a challenge to their cleverness.
4. This period should come at a time when your class would perhaps be refreshed by a few minutes' change and relaxation.
5. But remember that there will be times when you will have to take your lesson period at whatever moment opportunity knocks. A yellow warbler might appear outside your window at 9:15 quite regardless of your schedule. In the same fashion your monarch butterfly might decide to emerge from his chrysalis while you were in the middle of an arithmetic lesson. Or a pupil might bring in something so exciting that it would have to be talked about immediately.

IV. CORRELATIONS

Your nature study discoveries and enthusiasms, problems in conservation and humaneness and other phases of this work, work in pleasantly, you will find, with various other subjects.

1. Drawing and design.
2. Oral and written English, in the form of stories, letters, dramatizations and poems.
3. Geography, as in the migrations of birds, the ranges of animals, the distribution of trees, the travels of weeds, domesticated plants, insects.
4. History, as in Indian life, colonial life, dye-stuffs and tea-substitutes of the Revolutionary and Civil Wars. Did you know that our common white daisy immigrated to America at the time of the Revolution, in the hay brought over for King George's cavalry?
5. Arithmetic, as in the food of birds, the travel of birds, the value of forests, the destruction of game, the destructiveness of rats, the value of food plants.

V. WHAT IS IT?

What a natural first question when a new object is discovered! If we can answer that question, good. If we can't let's see if we can find the name. When a child fires a "What is it?" at you, fire back with the more important question—

What is it doing?
Why is it doing it?
Why is it where it is?

VI. THE PROBLEM OF NAMES

Names are good things to know—but not an end in themselves. To know how a thing lives and fights its battles is more important than to know its name. Names are only a great convenience, giving us that much extra mastery of our mother tongue and enabling us to talk intelligently. They help build up acquaintance. The creature with a name seems to stand out more as a living individual and a personality than one without a name. Names need not be the bugbear we sometimes make them. By using them often and naturally in your talks with the children, unfamiliar names soon sound familiar to your boys and girls. Don't suggest that the new names are hard names. A child uses such names as "Chevrolet" and "Pontiac" without

ever stopping to think whether they are hard or easy. Then why should he shrink from such names as "hepatica" or "columbine"?

VII. THE OLD QUESTION—WHAT IS IT GOOD FOR?

There are great numbers of living things which are, of course, directly or indirectly good from the human standpoint; and many others which are not, and still you will be asked: "What are they good for?"

The only proper answer is that such things are good for themselves, prizing their own lives in their own way and going about their business of living in this world to the best of their ability.

That is what they are good for—just as that is what we are good for—in mother nature's eyes.

It is as true of the worst pest (as we see it) as it is of the most useful mammal, bird or plant.

VIII. OBSERVATION AND DESCRIPTION

Encourage your boys and girls to give as full descriptions as they can. It's a good habit to acquire.

They can not describe well, you see, until they have observed well; and the habit of "taking in" important details is one that we should like to have them fall into.

By giving them constant opportunities to describe, in the course of your discussion, you bring them to see for themselves the need of making better use of their eyes, ears and finger-tips. You encourage them to go back and look again.

Begin by letting them describe specimens which they have in their hands or which are right before them.

This is the best of preparation for carefully seeing and adequately describing things which can not be brought into the school—for instance, birds.

A dandelion, for instance, is very much more than a yellow flower. It has leaves of a certain pattern (with which it manufactures food from the air). Its leaves are arranged in a rosette, not on a long stem. It has a hollow flower stem, with milky juice. Its blossom is made up of very many little flowers all crowded together—a composite. It has a long tap-root reaching deep into the ground. This enables it, in times of drought, to get its supply of water more successfully than many other plants. It has a bitter taste. This protects it from grazing animals. It is strong and hardy and overcomes obstacles. See how it contrives to bloom even below the level of lawn-mower blades. It grows best—where?

This business of hunting down certain details can easily be given the flavor of a game, a sort of hide-and-seek.

Once the child knows what to look for, he'll be getting these important details more quickly and easily than we grown-ups can hope to.

IX. THE NOTE-BOOK

Encourage the keeping of note-books in the upper grades. Encourage the boys and girls to set down in these books anything that seems interesting or important to them, whether they've seen it in class or by themselves. Let them illustrate these books, in any way they wish, to their hearts' content. Encourage them to remember to put down dates and places. These books are not to be criticized for spelling or grammar. The most you will do is to talk over with the child the contents of his note-book. It's HIS book.

X. THE MATTER OF LIFE AND DEATH

The question of death is bound to appear often in nature study. Treat it simply as a natural thing, as natural as life, as a circumstance common to all.

Yet one of the purposes of nature study is to teach reverence for life.

When your boys and girls see the robin swallow the earthworm (which is not, of course, so good for the earth-worm) it is easy enough to switch the sympathy of your youngsters to the hungry robin. The robin is, after all, only satisfying his honest needs—just as we satisfy ours when we eat chicken-meat, pork-chops, fish, and clams.

Some living things are always having to die because other living things are hungry. This matter of dying for a purpose, to fill a real need is one thing. But dying just to give us the fun of killing is another. There is very little of this sort of killing in nature. Weasels, cats, skunks and people are the outstanding wasters.

When a boy kills a bird for the fun of it or a toad, because he is ignorant, this matter of death requires more emphatic treatment, from the standpoint of the rights of living things, of the golden rule, good sportmanship, conservation and the law.

In this whole matter of treating the questions of life and death, common sense makes a better guide than pure logic.

XI. THE MATTER OF FEAR

1. Are your pupils going to be afraid of some of the small wriggling creatures—spiders, bugs, caterpillars, toads, salamanders, garter snakes? Not your boys, I'm willing to wager! The lure slimy and creeping things have for them, the casual way in which they carry snakes and mice about in their pockets are a gift of the gods to you. Make the most of it! There's no better way to hold the pupils' interest in nature study and to prove to them that you're interested in what they consider interesting. By the same token, discouraging their enthusiasm for "snaps and snails and puppy-dog tails" is an excellent way to turn their interest into boredom. Your boys can, indeed, be a tower of strength to you in your collecting and in the care of your captives.

But there will be others, perhaps, in your room, who will be afraid. One of the ends of nature study is to remove this fear—or prejudice, or superstition—through a better understanding. As the child becomes acquainted with some of these little creatures, in a terrarium, perhaps, right in your room, her fear will drop away from her.

2. How do you feel about these things yourself? Unhappily, an aversion to some of the forms of life has, from infancy, been so well ingrained in many of us that it's almost impossible to shake it off.

For one thing, your boys can relieve you of much of the actual handling.

Wearing a glove, should you have to do the handling yourself, you'll find a comfort and reassurance.

As a matter of fact, many of these creatures are so small and so likely to be injured by our great fingers that they are captured much more pleasantly and safely (both from their point of view and from yours) in some indirect fashion such as slipping a piece of paper under them or steering them into a small box (with a cover) or, as in the case of caterpillars, by bringing home the caterpillar and the twig or plant on which it is feeding.

XII. LESSON MATERIAL

Your nature study material is collected in two ways: (1) in field trips, and (2) by the boys' and girls' own collecting. You won't lack material, if you leave it to them! But don't waste it! (That's conservation.) In field trips you can, with a fair degree

of success, avoid too much useless duplication. In the collecting done by the boys and girls, ask for volunteers and make assignments. If, for example, you should in the fall be studying wild fruits that attract birds, begin by asking two or three to bring in wild fruits which they believe the birds like. When these have been brought in, ask for volunteers who will look for fruits different from those you already have. Build up your collection, day by day, in this fashion.

Don't be afraid to use dead material—provided, of course, that it's not too dead! The creatures of the wild suffer their mischances, too. Birds in cities, for instance, sometimes break their necks by flying into wires. With such material, if it happens to come your way, you can conduct a discussion, say, on the bird's fine equipment for its mode of life—beak, eyes, feet, wings, tail, feathers for warmth and "rain-coat" feathers—bringing such points home more vividly than you can at your usual long range.

XIII. MOUNTED COLLECTIONS

Collections of mounted specimens serve several ends. (1) They gratify the "collecting instinct." (2) They satisfy the child's pride; they are the visible proofs of his achievement. (3) They enable you to organize the assembled facts in the proper divisions and subdivisions. (4) They provide, in themselves, excellent visual instruction.

XIV. WHAT DO YOU COLLECT?

1. The objects themselves—to keep. Plants in any of their life stages; the leaves, twigs, blossoms, and seeds of trees; ferns, mosses, fungi; insects in their adult stages, insect galls and other insect homes; birds' nests *only* in the fall; any other material of a sort that can be conveniently handled and preserved.

2. The objects themselves—to return. Certain small mammals; certain small fishes; toads, frogs, and salamanders; caterpillars to enact their life histories for you; insects of many sorts; any of the small "fleshy" creatures, snakes, snails and all such things.

3. Records of the objects themselves. In the form of—Life stories as your boys and girls have seen them unfold; stories of the habits and manners of any creature your youngsters have been watching; pictures, either made by the pupils or clipped; calendars, such as bird calendars, butterfly calendars, a spring

calendar of the toads and frogs, flower calendars, tree calendars, and others.

XV. TAKE CARE OF YOUR CAPTIVES!

This is important! Do your best to see that the living things you have "borrowed" are returned in good shape. The care of your small captives, seeing that they are comfortable and well-fed, is an essential part of the work your boys and girls are doing in nature study. It is not only practice in humaneness but an opportunity to learn much about the modes of life, the habits, the likes and dislikes of their small prisoners.

1. See that your moth and butterfly caterpillars are kept supplied with the food they require. The kind of plant you find them on will tell you what that is.
2. See that the ants on your ant-island are kept dark most of the time and supplied with bread soaked in sweetened water, berry-jam, sugar, bits of raw meat, freshly-killed insects, and the like.
3. See that the toad in your terrarium has some moist sand—he "drinks" only through his skin—and that his food is given to him *alive*—flies, potato beetles, earth-worms; almost anything as long as it moves and is not too huge to swallow.
4. See that your salamander has an island to rest on, should he be in your aquarium. Feed him small earth-worms or leaves covered with plant-lice.
5. See that the fish in your aquarium are fed with earth-worms, flies, insects or bits of fresh meat; and that they have air to breathe—which is best provided by water plants growing in the aquarium itself.
6. See that your pond-snail—who is a vegetarian—has either green slime to eat or leaves of cabbage or lettuce.
7. Whatever your small prisoner may be, bear in mind how he lives when he's "at home" remember the kind of surroundings he likes to be in, try to imitate those as well as you can, and, if you don't know, look up what he likes to eat.

XVI. RETURN YOUR CAPTIVES TO THEIR HOMES

When you are through, see that your small prisoners are put back where you found them.

No matter if your prisoner should be a public nuisance like the house mouse or a pest like the tent-caterpillar!

When your pupils have become interested in any creature's

life and its battle with the world and they have been watching it and taking care of it is *not* the time to put any emphasis on the fact that it is a pest; or to allow it to be destroyed! The effect of such an ending to the story is, experience has shown, generally unfortunate. The pestiferous nature of certain creatures, the other side of the story, will stand out clearly enough in their relation to other nature study units. The tent caterpillar, for example, in a moth and butterfly unit, should stand out as an interesting, ingenious and successful insect. In a tree unit on the other hand, he stands out as a pest and an enemy to our trees.

XVII. THE FIELD TRIP

The field trip is a vital part of any nature study project. It is a voyage or exploration, a visit to headquarters, an excursion into the crowded city of living things, an adventure. It is needed, often enough, to give your project an enthusiastic start; to check up on various points as your project grows; and to round out gaps in your collection of information.

It is a problem, too, at times, when the youngsters' excitement gets the best of them, when they all want to talk at once, when they scream because they're thrilled. But their most furious talking is talk about the very things you've brought them out to see. Interest brought to such a pitch has, after all, its own high value; and has no practical ill effects except when you're trying to see birds or some of our small animals.

But there are some things you can do to make the field trip a smaller problem (from our point of view) and a more satisfactory enterprise (from everybody's point of view):

1. Talk up the trip with your boys and girls beforehand—what you are going to look for, how and where you're going to look for it, what you're going to do and how you'll do it, you and they together.

2. Make it stand out as an event, a treat and a reward which is worth "being good" for. By the same token, make it clear that those who won't "play the game" or regard the rights of their class-mates will have to remain in school when the next trip takes place. Let the children be the judges. (How often, in the spring bird-walks, I heard the youngsters complain indignantly when one or two of their mates would selfishly gallop ahead and scare the birds away.) The field trip is fine practice in co-operation and respect for the rights of others.

3. Organize the equipment and supplies you will need to bring back what you are going for, such adjuncts as baskets and boxes for plant specimens of all sorts—a tin box which excludes the air is the best; cigar boxes or small covered cartons for bringing home butterflies, moths, other insects and various small active creatures; a butterfly net and small bottle of gasoline, if you happen to be butterfly hunting; empty match boxes for the capture of spiders; some sort of dip net, if you're going to the water, and non-leaking pails to bring home not only the water-babies themselves but a supply of the water they live in, or the little water-plants you may need in your aquarium; jack-knives or scissors to obtain neat twigs and plant specimens; a trowel and empty baking-powder can, if you wish to bring back ants for an ant island.

4. Organize this equipment by distributing the various responsibilities among your boys and girls. The more they have to do, the better everybody will be pleased.

5. Encourage the use of the note-books on these trips—for those in the fifth and sixth grades especially.

6. See that the trip doesn't last more than an hour from the time you begin observing and collecting to the time you start schoolward. Attention lags. When the hour is up, start back. Let your boys and girls understand that they have only an hour at the most, and many things that they wish to do in that time.

7. Employ your more observant and experienced pupils as assistant guides and squad leaders. Put them in charge of definite groups to assist those groups in seeing and finding things.

8. Make your field trip an observation and collection adventure—with a minimum of discussion on your part. Discussion can be carried on much more successfully, afterward, in the schoolroom.

9. While you set out to do certain definite things in the way of seeing and finding, don't pass up any other interesting opportunities good fortune may put in your way. You may not have such luck again.

10. When your hunting—whatever you may be out for—grows poor, switch for a few minutes to something else which the youngsters can find. There are always trees and rocks.

11. If you come to a brook, you'll find that some of your boys will be in it—as sure as fate; the attraction is irresistible. Don't try to stop it, but turn it to use. Give them five minutes, say,

in which to find something of interest for the rest of you to see. Employ similar tactics when they begin to paw into a rotten stump or to turn stones over.

12. But don't waste material, please! Make your field trip a conservation demonstration. Talk over the whys and wherefores of being careful before you set out; and after you return. In the field, save the flowers and ferns from being pulled up by the roots. If you are looking for certain types of roots, see that these roots are dug up—not yanked up! Don't allow branches to be broken from shrubs and trees. Twigs and sprays may be taken—provided you have some need of them. Discourage the picking of purposeless bouquets, it is usually impossible to take any care of them, after they are picked. Under no circumstances permit a child to throw away any bouquet, large or small that he or she has picked.

Help your boys and girls understand why it is good to be careful and thrifty with the things that grow and live; why it is good to leave things uninjured—not only for their own sake but for the sake of other people as well. Other boys and girls may wish to see these things, too. Your pupils themselves may wish to come back there another day, another year, or in future years.

XVIII. SOME MAKE-BELIEVE CHARACTERS

These might well become familiar figures in your nature study talks, playlets, stories. (Their prototypes are not hard to find!) In the child-pilgrim's progress to the heavenly city of justice and humaneness, where the people are awake to the beauty and the value of their heritage and fear and superstition have been cast out, he will encounter the following:

Old Mrs. Moonshine, who knows that toads give warts, that dragonflies sting and sew up your ears, that bats get in your hair and then all your hair has to be cut off, that you'll get lousy if you let chimney swifts live in your chimney or barn swallows in your barn, that you'll die if a spider bites you, that all snakes are deadly, and a thousand other things which aren't true.

Mr. Dumb-bell, who believes that every hawk in the sky will destroy his poultry, that skunks subsist purely on chicken meat; that everything is out to do him a dirty turn; and who, as a consequence, shoots every hawk, breaks every snake's back, smashes every toad; who doesn't know and flatly refuses to believe that many of these creatures are doing useful work for humankind every day that they live.

Mr. Tightwad, who shoots the robin in his cherry-tree, unwilling that they should have anything of his, no matter how much service the robins have been giving him all the rest of the year; who, out of season, shoots the deer that has wandered into his meadow because it will eat some of his grass; who is greedy, stingy and ignorant, unwilling to share what has come to him.

William Commonsense (A pupil right in your room), who knows that it is a practical thing, just from the standpoint of his own comfort and welfare not to destroy or permit to be destroyed the many wild creatures that serve us in one way or another, birds, bats, toads, salamanders and milk-snakes.

Peter Fairplay (Another pupil in your room), who is a good sportsman. He doesn't believe it's any credit to him to torment and kill creatures that are so much smaller than himself, when they're doing him no harm. He finds out whether a thing is harmful or otherwise, before he condemns. Until he knows, he gives the small things he meets with the benefit of the doubt. He gives them the benefit of the law which insists that a man is innocent until he is proven guilty.

Mary Goldenrule (Another pupil in your room), who asks boys throwing stones at birds how they'd like to have stones thrown at them, and shuts up her cat nights or keeps it on a leash.

Jenny Braveheart (Another pupil in your room), who overcomes her dread of mice, toads, caterpillars, spiders, bugs and all such things; who refuses to let the boys appear so much braver than she is; she knows how those little things try to make a living and discovers that they aren't so dangerous, after all, and that many of them are constantly doing her good turns.

BUYING GOVERNMENT PAMPHLETS MADE EASIER BY NEW CARD SCHEME

A new method of purchasing government bulletins will shortly be offered to the general public, M. S. Eisenhower, director of information of the Department of Agriculture, told the House Committee on Appropriations.

At present, it is quite a complicated procedure to buy a five-cent publication from the Superintendent of Documents, who probably seems to the average citizen like the Keeper of The Great Seal, Mr. Eisenhower explained. Letter postage costs three cents, the five-cent money order costs seven cents; then the purchaser has to find out to whom to address the letter.

Under the new system, the purchaser will simply buy a special self-addressed postcard from his postmaster or rural carrier, and write his order on the back. The card itself will cost the total of his order, and the money will flow into the Treasury from the Postoffice Department direct.

EASTERN ASSOCIATION OF PHYSICS TEACHERS
One Hundred Twenty-Second Meeting

Teachers College of the City of Boston
Saturday, December 3, 1932

PROGRAM

9:45 Meeting of the Executive Committee.
10:00 Business Meeting.
10:15 Reports of Committees.
10:30 Address of Welcome: Dean William F. Linehan of the Teachers College of the City of Boston.
10:45 Address: "Physics as a Basis of Engineering." Mr. E. W. Davis, Electrical Engineer.
11:30 Report of Apparatus Committee. Mr. John C. Packard, Brookline High School, Chairman.
12:00 Address: "How Physics Laws Control the Fighting Weapons of Our Navy." Lieutenant Commander Ralph S. Parr, United States Navy.
12:45 Luncheon at a near-by restaurant.

SPECIAL NOTICE

The yearly meeting of the New England Association of Colleges and Secondary Schools is to be held at the Hotel Statler in Boston on December 2. Our Association, together with several other similar groups, is cooperating with them and our members are invited to attend their meetings. The program follows.

3:00 P.M. in the Georgian Room. Samuel P. Capen, Chancellor of the University of Buffalo, "Certain Problems in the Relation of Regional Associations to the Colleges." Willard W. Beatty, Superintendent of Schools, Bronxville, N. Y., "A New Freedom for the Secondary School."

6:30 P.M. Dinner. Speakers: President Ernest H. Wilkins, Oberlin College; President Stanley King, Amherst College; President Robert D. Leigh, Bennington College; President Louis J. Gallagher, Boston College.

OFFICERS OF EASTERN ASSOCIATION OF PHYSICS TEACHERS

President, LOUIS A. WENDELSTEIN, High School, Everett, Mass.
Vice-President, HOLLIS D. HATCH, English High School, Boston, Mass.
Secretary, WILLIAM W. OBEAR, High School, Somerville, Mass.
Treasurer, WILLIAM F. RICE, Jamaica Plain High School, Boston, Mass.

BUSINESS MEETING

The following amendment to the Constitution was adopted. Sec. V. Article 3, first sentence. To change the word "first" to "last" and the word "calendar" to "school" so that the amended sentence shall read. . . . "The officers shall be chosen at the last regular meeting of the school year."

The President read a communication from the Northeastern Section of the American Physical Society inviting the members of our Association to attend their meetings and become members of that Society.

The following were elected to active membership,

Mr. Joseph M. Arthur, St. Mark's School, Southborough, Mass.

Miss Mary H. Macdonald, Winsor School, Pilgrim Road, Boston, Mass.
Mr. Allen L. Dresser, High School, Rockville, Conn.
Mr. Carl Johnson of the North High School, Worcester, Mass. was changed from active to associate membership.

It was voted that the thanks of the Association be extended to Pres. Kennedy and his associates for their hospitality and to the speakers for their contribution to the program.

Dean William F. Linehan of the Teachers College took time from a busy morning to extend a welcome to us. He called attention to the fact that his institution which is 85 years old is now offering to the teachers of Boston a very large number of Science courses. He invited us to visit the classes in operation at any time.

REPORT OF THE COMMITTEE ON COLLEGE ENTRANCE REQUIREMENTS

BURTON L. CUSHING, *Chairman*

At a previous meeting, we considered a suggestion received from the Association of Science Teachers of the Middle States and Maryland that a revision of the content of the Physics' course should be considered. Their suggestion was that some of the topics be omitted in a one year course and that the course consist of one of the following groups:

GROUP I	*GROUP II*
Mechanics (a)*	Mechanics (a)*
Electricity (a)*	Electricity (b)*
	Heat or Light

GROUP III	*GROUP IV*
Mechanics (b)*	Mechanics (b)*
Electricity (a)*	Heat
Heat or Light	Light
	Sound

NOTE: Mechanics and Electricity (a) to constitute complete and more technical courses with problems and applications.
Mechanics and Electricity (b) to cover fundamentals only and to be less technical in character.

This was discussed at the meeting and the sense of the meeting was expressed as follows:

1. That the number of topics treated in the subject of Physics should not be decreased. To sanction the omission of two of the five major topics of the subject would be to admit that these topics at least, if not the whole subject, were not important.

2. That there be two different courses in Physics: (a) a one year course of six periods per week, of a more qualitative nature with considerably less mathematical work than is now required by the College Entrance Examination Board, and (b) a two year course of five or six periods per week, with she same mathematical requirement as at the present.

3. The Eastern Association of Physics' Teachers feels that the subject of Physics has grown in content and in importance until it merits two years' credit for college entrance, just as much as the languages and mathematics, such as French, German, Latin, or Algebra and through its Committee on College Entrance Requirements, respectfully submit this sug-

gestion to the Association of Science Teachers of the Middle States and Maryland.

4. That our Committee act with your Committee in arranging a conference with representatives of the College Entrance Examination Board for the purpose of requesting them to arrange two separate Entrance Examinations in Physics to cover the two types of courses outlined above, twice as much credit to be given for the two year course as is now given for a one year course.

Your committee communicated with the other Association reporting the sense of our meeting. In reply we received a letter from the chairman of their committee stating that he would present our conclusions to his society at their next meeting. As yet, it is too early to receive a report from their meeting.

On motion of Mr. LeSourd of Milton Academy, it was voted to have this matter discussed at our next meeting by members of the Association, for the purpose of deciding upon some further recommendations concerning the content of the course. This matter was left in the hands of your committee on College Entrance Requirements and such a discussion will be arranged.

REPORT OF COMMITTEE ON MAGAZINE LITERATURE AND NEW BOOKS

CARL W. STAPLES, *Chairman, Chelsea High School*

BOOKS

"Directed Studies for the Physics Laboratory," by Burton L. Cushing, Ginn & Co., Publishers.

A Manual to accompany Stewart, Cushing, and Towne's "Physics for Secondary Schools."

Contains 60 experiments with directions which are very clear, without telling the pupil what to expect as regards results, and without answering each question by a succeeding one, as is so often the case in laboratory manuals.

"First Principles of Physics," Fuller-Brownlee-Baker. 1932 Edition, Allyn & Bacon, Publishers.

The new edition has returned to the order followed in editions preceding that of 1925. The departure from the former order of the text-book, made in the 1925 edition, was not met with favor by many teachers. There are many new illustrations and numerous changes in material.

"Chromium Plating," by E. S. Richards, $3.65.

"From Telegraphy to Television," by Lt. Col. Chetwoode Crawley.

"Modern Physics," by G. E. M. Chauncey, N. Y. 1932, D. Van Nostrand Co. $4.00.

"Eclipse of the Sun," by S. A. Mitchell, 3rd Ed. revised. N. Y. 1932, Columbia Univ. Press, $5.00.

REFERENCES TO PERIODICAL LITERATURE

"Relevance and Scientific Method," Everett W. Hall, *Journal of Philosophy*, Sept. 29, 1932, p. 553.

Astrophysics

"Physical and Observational Evidence for the Expanding Universe." J. H. Reynolds. *Nature*, Sept. 24, 1932, p. 458.

"Aurore Polaire et Rayon Cosmiques." *L'Illustration* Aug. 13, 1932, p. 484.

"Eclipse—1932 Style. What it Meant to Science." J. C. Boyce, *Technology Rev.*, Oct. 1932, p. 9.

"The Total Solar Eclipse of Aug. 31, 1932," *Popular Astronomy*, Aug.–Sept., p. 379.

Atmosphere

"A la Conquête de la Stratosphère." (The second ascension), *L'Illustration*, Aug. 27, 1932, p. 524.

"The Meaning of Piccard's Feat. Atmospheric Exploration Illustrated." *The Illustrated London News*, Aug. 27, 1932.

Electricity

"Dual Voltage Connections for Induction Motors." A. C. Roe, *Maintenance Engineering*, Oct. 1932, p. 384.

"Submarine Cable Insulation" (2 new materials) F. A. Middleton, *The Electrical Rev.* (Lond.), Sept. 23, 1932, p. 421.

"The Piccadilly Tube Extensions," *The Electrical Rev.* (Lond.), Same p. 367.

"Sodium Filled Pipes Better Conductors than Copper." *Electrical World*, Oct. 1, 1932, p. 405.

"Cadmium Bronze Trolley Wire," *Transit Jr.*, Oct. 1932, p. 481.

"High Voltage Surge Tests on Standard Air Gaps." F. D. Fielder (Westinghouse) *Electric Jr.*, Same p. 459.

Heat

"Low Temperature Refrigerating Machines." Otto Wagner, Wiesbaden, *Engineering Progress*, Sept. 1932, p. 192.

"Mechanically Refrigerated Railroad Freight Cars." Horace M. Wigney, *Railway Age*, Oct. 1, 1932, p. 458.

"Hook-ups. The Old and New Warm-Air Plants, Radiator Heat, and Air Conditioning." *Heating and Ventilating Magazine*, Oct. 1932, p. 27. (Other articles on related subjects in same.)

Historical

"Richard Arkwright and the Early Years of the Industrial Revolution." (Textiles) H. R. Taube, *Mechanical Engineering*, Oct., p. 677.

"What Electron Tubes are Doing." W. R. King (G. E.), *Maintenance Engineering*, Oct. 1932, p. 377.

Hydraulics

"Hydro-Electric Development & Correlation of Hydro and Steam Power." F. A. Allner, *Mechanica Eng.*, Oct. 1932, p. 677.

"Moving Mountains at Hoover Dam." *Electric Jr.*, Oct. 1932, p. 479.

"Hoover Dam, Materials, Supplies, Man-power, and Program of Future Work." Walker R. Young, *Sci. Am.*, Oct. 1932, p. 222.

"Water Power in Palestine." *The Electrical Rev.* (Lond.), Sept. 23, 1932, p. 425.

Light

"Ultraviolet Measurement During the Solar Eclipse." *Electric Jr.*, Oct. 1932, p. 481.

"Ultraviolet Light and Forgery." Elbridge Walter Stein, *Sci. Am.*, Oct., p. 204.

"Things that Happen in Sunspots." Henry Morris Russell, *Sci. Am.*, Oct. 1932, p. 208.

Several Articles on Spectra in *Physical Rev.*, Sept. 15, 1932; *Astrophysical Jr.*, Sept. 1932.

"Find Mysterious Error in Speed of Light." John L. Coontz, *Popular Science*, Dec. 1932, p. 37.

"Mystery Rays that Cure Diseases." Alden P. Armagnac, *Pop. Sci.*, Dec. 1932.

Mechanics

"One Stage Serves Two Theatres." D. S. Bowman, *Electrical West.*, Sept. 1, 1932, p. 102.

Meteorology

"The Wrath of the Weather Demons," Andrew R. Boone, *Travel*, Oct. 1932, p. 22.

"Trailing Ice-bergs on the North Atlantic," Beran Landsowne, *Travel*, Oct. 1932, p. 30.

Molecular and Atomic Physics

"The Fundamental Particles." *Science*, Fri. Sept. 30, p. 294.

Radioactivity

"The Radium Content of Some Hungarian Rocks." S. S. DeFinaly, *Am. Jr. of Sci.*, Oct. 1932, p. 306.

Sound

"Bells the World Over." Lucy Embury, *Travel*, Oct. 1932, p. 34.

Testing Materials

"Looking at Stresses." Max Frocht, Ph.D., *Sci. Am.*, Nov. 1932, p. 280.

"Definition of the Inch." H. W. Bearce, *Mechanical Eng.*, Oct., p. 689.

"Nation's Largest Precision Testing Machine Installed in U. S. Laboratory," *Electrical West.*, Sept. 1, 1932, p. 121.

Transportation

"The Manhatton," Largest American-built merchant vessel, *The Marine Engineer*, Sept. 1932, p. 302.

"Turbine-Driven French Cargo Ships," *Marine Engineer*, p. 309.

"Welded Barges." Gordon G. Holbrook, *Marine Engineering*, Sept. 932, p. 399.

"Pneumatic-Tired Rail Vehicle, Developed in Austria," *Transit Jr.*, Oct. 1932, p. 411.

"The Lines that Cannot Roll." (Gyro-Stabilizers), *Sci. Am.*, Oct., p. 224.

REPORT OF COMMITTEE ON CURRENT EVENTS

J. P. BRENNAN, *Chairman, Somerville High School*

At the Mellon Institute of Industrial Research in Pittsburg, Dr. A. W. Coffman has succeeded with the aid of heat and pressure in cementing felt and steel together into a single sheet. This felted sheet will enable engineers to obviate the ring inseparable hitherto from metals. Corrosion of the steel may be prevented by saturating the outer felt surface with paint, laquer or similar substances. By combining asbestos felt with the metal and saturating the felt with suitable materials a fireproof sheet is obtained. The felted metal can be sheared, bent, corrugated, rolled and drawn as if it were a single sheet.

Engineers of the National Broadcasting Co. from a study of the sunspot frequencies and the Heaviside Layer have prepared charts which enable them to predict "radio weather" several weeks in advance. These charts are being used in the selection of dates for broadcasts across the ocean.

Drs. Vannear Bush and T. S. Gray of M.I.T. have incorporated the photoelectric cell in a new development of the integrating machine which they invented a few years ago. Light beams that fall upon the cells pass through apertures with shapes that represent graphically the functions to be multiplied or integrated.

At the University of Leyden a Huge electromagnet was recently dedicated to the task of tearing apart the atom. The magnet is to be used in connection with liquid helium. Temperatures approaching absolute zero

must be maintained to prevent the magnet from overheating from the powerful currents that will flow through its coils.

In the laboratories of the Eastman Kodak Co. photographic plates have been perfected which are so sensitive to heat rays that they must be packed in ice to prevent them from being fogged by radiations from the plateholders in an ordinary room. The plates are several times faster than any hitherto made for infra-red photography.

Dr. August Hund, formerly of the Bureau of Standards and now associated with Wired Radio, Inc., has demonstrated a "cold" radio tube for use as a detector. It is about the size of a fountain pen and calls for only a small dry cell to give it life.

Dr. Laurence E. Dodd and W. W. Harper, physicists of the University of California, have devised a method of timing runners and racing automobiles so accurately that thousandths of a second may now be considered. A copper wire is stretched across the muzzle of the starting pistol and is broken when the pistol is fired. Thus an electric circuit is broken and a high speed chronograph starts to register. At the finish line a beam of light which shines across the track and falls on a photoelectric cell is momentarily blocked by the runner as he crosses the line and a signal is sent to the chronograph. Hence there are two marks on the chronograph, one indicating the starting instant and the other the finishing instant.

At the annual meeting of the National Academy of Sciences held in Washington, D. C., on April 25, Dr. Robert A. Millikan of the California Institute of Technology revealed the results of the first successful direct measurements of the energy of the mysterious cosmic rays. The evidence, Dr. Millikan said, was in favor of the photon interpretation of the cosmic rays and he added that the suggestion that the rays may be interpreted as neutrons does not appear to conform with the facts which have been established.

Drs. Leslie A. Chambers and Newton Gaines of Texas Christian University have shown that it is possible to kill bacteria in liquids and sterilize milk by means of audible sound vibrations. The apparatus consists of a nickel tube which is made to vibrate electromagnetically at the rate of about 18,000 times a second. Milk is continuously sterilized by forcing it into close contact with the vibrating tube. It is claimed that this process is more effective in the sterilization of milk than pasteurization and produces no change in the chemical composition and flavor of the milk as pasteurization does.

The Cunard liner Scythia is burning colloidal fuel, a mixture of powdered coal and oil. A pound of the mixture possesses a much greater heat value than an equal weight of coal. When storage space is of importance as it is on ships, this greater 'heat density' has evident advantages.

The photoelectric cell is called upon to do another job. It is used to give warning of the escape of mercury vapor in mercury vapor power plants. A beam of light is reflected from a strip of paper coated with selenium sulphide, a compound quickly blackened by mercury vapor. As soon as the paper darkens, the amount of light that it reflects to the photoelectric cell is reduced and an electric circuit is affected. Either a light is flashed or a bell rung to give warning of the escape of the vapor.

Some photographs made by Drs. Freundlich, von Klüber and von Brunn of Einstein own Potsdam observatory during the total solar eclipse of 1929 led the great relativist to doubt the validity of his own theory or, at least of his original calculations. He had predicted that a ray of starlight as it grazed the sun during the eclipse would be deflected by 1.75 seconds of arc. Freundlich announced that the measurement of 1929 showed a displace-

ment of 2.25 seconds of arc; a difference so large that Einstein actually rose in the Prussian Academy of Sciences to state that he must have been wrong and the whole theory of relativity perhaps required re-examination. Recently Dr. Robert J. Rumpler of Lick Observatory, California, came to the rescue. He reported in Science that Freundlich and his associates failed to make some necessary corrections when they measured their photographs and that the observed deflection is actually 1.75 seconds, "in precise agreement with the Einstein theory."

Engineers at the General Electric Laboratories at Schenectady recently "conversed" a distance of about thirty miles by means of a beam of light A search light mounted on the roof of the laboratory cast the beam of light to a concave mirror theiry miles away on the side of a mountain. At that distance the searchlight looked like a twinkling star.

The television station atop the Empire State Building in New York City is in operation. In May the Radio Corporation of America staged a private demonstration for a group of executives and engineers of the trade so that they might view the progress made and prepare for future marketing of television apparatus. The pictures shown measured 4 by 5 inches and were described by one of the engineers present as "fairly clear." It is believed that by the autumn of 1933 the stage may be set for television on a nation-wide scale.

PHYSICS AS A BASIS OF ENGINEERING

By E. W. Davis

Electrical Engineer—Simplex Wire & Cable Company

(Abstracted)

It is perhaps presumptuous for one outside the profession of teaching to discuss briefly before this Association the subject of Physics and its relation to engineering. On the other hand, when one sees the evident lack of appreciation of the importance of this subject to whatever line of endeavor the student may pursue after leaving school, professional or otherwise; when one sees the tendency to spend enormous appropriations for nonfundamental subjects in our public and secondary schools; when one meets in the engineering profession men who are limited in their accomplishments because of a lack of knowledge or understanding of the fundamental principles of physics: then I believe that a protest against the apparent nonrecognition of this fundamental subject is justified.

Physics together with the allied subjects of chemistry and mathematics, is the fundamental background of all scientific accomplishments since the start of civilization. A long list could be made of such accomplishments and inventions: the telegraph and telephone, automobile, radio, electrical appliances, moving pictures (both silent and sound), airplane, etc. The truly remarkable increase of the distances for speech transmission is due wholly and solely to the better understanding of the basic principles of resistance, inductance, leakance, and capacitance, (fundamentals of Physics) and not to any great change in mechanical design or construction of apparatus.

The tremendous increase in the use of electrical power in our suburban

and rural areas is made possibly by application of fundamental principles of physics for the transmission of this power from place to place.

Physics stands today as the one fundamental science that is basic in practically all branches of human thought and human endeavor. I believe that the fundamental laws and principles of physics are better evidence—proof if you want that word—of the existence of God and of His guiding powers—than many of the parables and much of the theological reasoning that is commonly accepted today.

The study of physics received its real impetus during the last century, and today we have laboratories of colleges, universities, and large manufacturing organizations spending enormous amounts of money, time, and energy in research and in study of fundamentals.

One author ("Science & Physics"—Stewart, Cushing, and Towne) has subdivided the subject of physics into five divisions:

1. Mechanics and Prospectus of Matter.
2. Heat.
3. Magnetism & Electricity.
4. Sound.
5. Light.

Such a division may be correct, but a student of engineering, who confines himself to any one of these subdivisions at the expense of the remaining four, is handicapping himself. I do not know of any one line of engineering that confines itself to fundamental principles of any one of the above divisions. My own experience as an electrical engineer does not justify a recommendation that future electrical engineers should confine their studies to the third division—i.e., magnetism and electricity.

If I were to recommend to a parent the proper course of study to prepare a boy for the engineering profession, I would without hesitation recommend the study of physics. Too much attention is now being paid to educating specifically electrical engineers, mechanical engineers, civil engineers, etc. "Forget the type of engineering and major in physics" is my advice to students today.

There is another phase of the study of physics that is of inestimable importance as a medium of education, but which unfortunately has been often overlooked—i.e., the mental development. What a student learns in school is of little or no value unless in that process of learning, he has developed the ability to think. There is no study in the entire school curriculum that can produce as much mental development as the study of physics and mathematics.

A school should be nothing more than a mental gymnasium where the student goes to develop and train the mind. A school for mental development is similar in its value to the physical gymnasium for the development of the body. In the latter case, exercises are given for the one purpose of preparing the human body to function speedily and properly when needed. Similarly, the school should aim to develop the human mind to function logically and speedily when the student goes out into the business world.

Many of my classmates of the course in Electrical Engineering at Massachusetts Institute of Technology have gone into the insurance, bond, or banking business. I do not believe, nor do you believe—that the four years spent at Massachusetts Institute of Technology studying physics, mathematics, etc., were wasted on them because they became bankers. I believe that the mental training that they received during their time at Massachusetts Institute of Technology is of as much value to them as bankers or bond brokers, as it would have been if they had pursued the profession of electrical engineering.

I am not condemning the so-called practical arts or vocational courses that are so popular today in our secondary schools. On the other hand, I do not believe that they have any place in a purely educational institution or system.

The engineer must be one who thinks fearlessly and logically; one who is thoroughly familiar with the fundamentals of science; one who can differentiate between the probable and the possible; one who has courage of his convictions on the great problems that face the world today. The engineer with his thorough knowledge of the fundamental laws of science and existence can do more to relieve the distress and confusion of to day than any group of dreamers or romancers who ever existed.

REPORT ON NEW APPARATUS COMMITTEE

JOHN C. PACKARD, *Chairman, Brookline High School*

Mr. Charles S. Lewis of Wentworth Institute, Boston, showed a model alternating current generator designed and made by the more advanced boys in an electrical class to illustrate the generation of single phase and three phase voltages. A rotating magnetic field machined from a short piece of 3 inch steel shafting with its field coils energized from a 12 volt battery was rotated by hand at about 120 R.P.M. From two stationary armature coils on removable pole pieces voltage was brought off to a three wire single phase line, which was enough to bring 2 flashlight bulbs up to full brilliancy. All connections were clearly shown by white lines on a black terminal board from the armature coils to the bulbs. At this speed 2 cycle single phase voltage resulted as shown by flashing of lamps. The arrangement of the terminal board was such that the effect of balanced or unbalanced loads and also the result of a broken neutral line could be seen. One of the armature poles was now removed from its first position and, with a third pole similar to it, the three were placed 120° apart. Terminals from these three armature coils were connected through six wires to three flashlight bulbs on a second terminal board. Here again when the field was rotated at about 2 turns per second each of the three lamps could be seen to brighten up in turn as a N or S pole passed by its respective armature coil. Following this a third terminal board was shown on which the six wires were combined to three. The flashlights were now operating on a 3 wire 3 phase delta system.

Mr. Hollis Hatch of English High School, Boston, gave a short talk on anti-freeze compounds used in automobiles.

The temperature protection that anti-freeze compounds will give an automobile radiator is easily calculated for un-ionized materials. The de-

pression of a solvent's freezing point is directly proportional to the weight of solute and inversely proportional to the weight of solvent and the solute's molecular weight (Walker: Physical Chemistry). Reduced to a formula: $D = 1860\, AS/MW$ where D is the centigrade freezing point lowering, 1860 a constant used if water is the solvent, A the volume of anti-freeze, S its specific gravity, M its molecular weight, and W the volume of water.

Using the above this table gives the temperature depression for a 12 qt. (Model A) radiator when one quart or one gallon anti-freeze is used. The temperatures are changed to Fahrenheit:

Name	M	S	Boils	D (1 qt)	D (1 gal)
Methyl Alcohol	32	.79	153F	7.5F	41F
Ethyl alcohol	46	.80	172	5.3	29
Glycerine	92	1.27	554	4.2	23
Ethylene glycol	62	1.13	388	5.6	30

The above indicates that each has its advantages. Wood alcohol gives the most depression but boils at a temperature radiators often attain. It is not practical by itself but is a denaturant for ethyl alcohol that is useful while it lasts. Ethyl alcohol gives less protection but boils away more slowly and is the cheapest. Glycerine gives the least protection and in strong concentration or at low temperatures gives a quite viscous liquid. On the other hand it does not boil away at all and is less expensive than the last, ethylene glycol. This glycol is best except for cost. The relative freezing point depression of the last three is 1 to .79 to 1.04; the relative retail costs at present are 1 to 2.6 to 5.8.

A number of concerns are marketing a mixture of half glycerine and ethyl alcohol; they evidently believe it is the best compromise on cost, protection and permanence.

Mr. Rice showed a simple form of Cartesian diver in a quart bottle; Mr. Perry showed the use of a neon lamp with a rotating mirror, and Mr. Bowen showed a set of new style Magdeburg hemispheres and a motor driven device for producing waves in a long rubber tube.

HOW PHYSICS LAWS CONTROL THE FIGHTING WEAPONS OF THE NAVY

LIEUT. COMM. RALPH S. PARR, *United States Navy*

It is with unusual pleasure and a deep appreciation of the honor extended to me that I address this distinguished audience this morning. How the laws of Physics, with which you are all thoroughly familiar, controls the fighting weapons of our Navy with which I for many years have been familiarizing myself, is a subject so comprehensive and so broad that I must beg your indulgence because I am forced by the time at my disposal to treat it more or less in outline. I feel sure however you will be able to fill in the gaps from your own knowledge of the laws in question.

It is one of my most pleasant memories to recollect the surprised satisfaction which I felt some twenty-seven years ago when I began my study of Physics. The door had opened for me to learn the how and why of all the natural phenomena which had puzzled my boyish mind. There was my opportunity to understand, and I enjoyed the course thoroughly. Pe-

culiarly enough some fifteen years later I enjoyed teaching that same subject to Midshipmen at the Naval Academy. Two years after that I was intimately connected, as Gunnery Officer, with the fighting weapons of what was then the most modern type of cruiser. Two years later I taught Midshipmen the elements of gunnery, instructing in interior and exterior ballistics, of which the laws of physics are the very heart and soul. So it is with a very humble spirit and yet a sense of professional pride that I speak to you this morning on this subject which is of deep interest to all of us.

The fighting weapons of our Navy include the great guns of our Battleships, the torpedoes with which almost all Naval vessels are provided, the aeroplanes which are more and more becoming an essential part of our Naval armament and which in themselves carry their own peculiar weapons, and all the highly technical control instruments by which these weapons are directed against the enemy in battle in the event which we all hope may never come but must always be ready and prepared to meet.

The fighting weapons of a ship are collectively termed the armament. The armour on turrets, conning tower, ship's sides and armoured decks is known collectively as the protection. The engines, boilers and auxiliaries which furnish the motive power for the vessel are known as the power plant. The ship's structure is built to float the limiting weight designated by treaty limitations and that weight is the total of the three elements just named. In the design of the ship the amount of weight which can be assigned to the ship's armament must be determined in relation to the weights assigned to protection and to power plant. More speed means more power plant and means less armament and protection. In the first design of the ship a compromise between these three must be effected in order that the ship shall be best suited for its ultimate purpose. In the disposition and placing of various elements of the armament, not only must its military efficiency for use in action, that is, battle, be considered, but the stability of the ship against the rolling and pitching motion imparted by rough seas must be carefully provided for by the longitudinal, lateral and vertical placing of heavy units such as turrets, aeroplane catapults, etc. In the preliminary work of the ship's design these things are carefully checked by miniature models made exact as to size and weight ratios. These models are then tested in a testing basin of water with almost exact reproduction of open ocean motion. Stability is a "sine qua non" of a war vessel because the accurate direction of the great guns requires that the motion of the platform, upon which they are mounted, shall not be too irregular or abrupt.

From the old single casting, smooth bore, muzzle loading carronades, firing a spherical projectile, weighing sixty to one hundred pounds at the most, at very short ranges, in the days of our Tripolitan wars, to the modern high power naval rifle firing an ogival shell as great as sixteen inches in diameter and weighing approximately one ton, with a range in excess of twenty miles, is an epic story of advance in metallurgy and de-

velopment of pressure resisting methods of gun construction, and the laws of Physics applied almost exclusively.

The modern high power rifle is made up of successive cylinders of steel of enormous tensile strength. Starting with the inner cylinder or tube which is rifled to impart a rotating motion around its longitudinal axis to the shell in flight, the next cylinder is made so that its inner diameter is slightly less that the outer diameter of the inner tube and, by heating, it is caused to expand until it can be slipped over the inner tube and in cooling it shrinks on to the inner tube setting up compression in the tube and tension in the outer cylinder. In the same manner successive cylinders, up to a total number of four or five in larger guns, are shrunk on so that in the assembled gun there is a succession of static pressure forces, of alternate tension and compression, sufficient by their cumulative effect to balance the enormous pressure of the exploding powder charge in the chamber, which imparts to the shell its high velocity. The longer the gun the greater the opportunity for the powder pressure to operate and increase the velocity, but the gun's rigidity to maintain its straightness and still remain easily moveable lies completely in the barrel's rigidity. This limits the total length because as the length increases from the point of support at the trunnions, the muzzle tends to droop. Gradually we have been able to lengthen the guns and the corresponding range of our weapons. The increase of diameter has helped this. Advancing metallurgical skill may still increase it further.

The energy released by the exploding powder charge to impart the high velocity to the enormous mass of the shell must have its equal and opposite reaction. That reaction requires the structure of the ship to take up this force at its point of local application. The ship's structure is made especially strong and in the gun mount itself the recoil cylinders operate to let the gun actually move to the rear a certain distance, and during this motion reduce gradually the enormous energy thrust until it is completely dissipated. The recoil cylinders, with their pistons, are of special design for this purpose. "In battery," or in the gun's normal position at rest, the recoil cylinder piston is completely in the cylinder. The cylinder walls have long grooves, larger at the starting end and tapering rapidly to the other end. Around the piston rod, extending from the piston to the end of the cylinder, are enormously strong coiled steel springs. The cylinder is filled with a mixture of glycerine and water, which makes a smooth flowing but viscous liquid which will not freeze in cold weather. Nor will it expand excessively in hot weather. When the gun starts to recoil, at the moment of firing, the glycerine flows through the grooving in the cylinder walls from one side of the piston to the other and the speed of this passage becomes slower and slower as the grooves become narrower. It should be understood that either the piston or the cylinder is secured to the recoiling gun while the other member of the pair is secured to the fixed mount. The springs in the cylinder serve the two fold purpose of resisting the recoil

until it is stopped and then by their expansion forcing the gun back to its normal position, in battery.

For properly directing the gun in the horizontal and perpendicular planes, the mounting is so designed as to provide for the gun moving vertically on its trunnions, which are attached as an integral part of the sleeve, which has a close sliding fit, with a guide, around the outer cylinder of the gun proper. The trunnions rest in trunnion seats which are in the form of a yoke supported on a pivotal mounting, which allows for swinging the gun laterally. In the latest types of our fire control system, the guns are pointed in elevation and trained laterally by mmebers of the gun crew known as pointer and trainer. In order to synchronize the individual guns or turrets with each other and control the whole battery as one unit, an electrical follow up system with an indicator for the pointer and trainer at each gun is operated from the master sight, or director, high up in the ship's structure, to give the maximum range of vision. The firing circuits are electrically connected so the firing pointer at the director can fire all the guns simultaneously, in "SALVO" as we call it. With the advance in electrical science, the old direct current, step by step, system first employed by the British Navy and given to us as an ally during the war, has been superseded and largely replaced by alternating current and synchronized motors evolved, developed, and improved by our own General Electric Company. In this system the pointer or the trainer when in operation moves his gun so that his dial keeps in exact synchronization with the dial controlled from the director. The parallax, between guns at opposite ends of the ship firing abeam, is automatically compensated for in the instruments in order that at the point of impact the shells of the two guns will hit the same spot, theoretically. In actuality it is miraculously near the theory. How the components of lateral displacement with the necessary compensation for change of range have been worked out in the design of these instruments is just another application of vector diagrams with which you are all familiar.

I need not dwell upon the use of lenses in our sight telescopes or how we get the magnified image of the objective at which we aim. It may, however, interest you to know that, to make a greater depth or distance perception for the spotting officer, who estimates the error in the fall of the shots, in order to apply a proper correction to bring them on the target, we have designed for him a spotting glass involving the binocular principal but with the two objective lenses several feet apart in order to give the greater angular variation for a given range difference. The accuracy of our range finders depends largely on the distance between the two objective lenses. By super-position of the two images of the target, which can be adjusted mechanically, the adjustment is measured on a visual scale which gives the distance in yards to the target. To get greater distance between the two objective lenses, range finders are incorporated in the tops of the great guns turrets with the objective extending on each side of the turret and pointed in the same direction as the guns of the turret. An even greater

distance between objective lenses is desirable for increased accuracy but is not practicable to obtain on board ship.

In the subject of ballistics we divide that portion within the gun, known as the interior ballistics, from that outside the gun, called exterior ballistics. Within the gun the shell is given its initial impetus by the pressure resulting from the early stages of combustion of the powder charge. The copper rotating band, which is sweated on to the circumference of the shell at its base, makes a tight seal to prevent the powder pressure from escaping past the shell, and at the same time gives a soft surface to be bitten into by the rifling and insure the proper rotation of the projectile as it passes through the bore of the gun. The resistance of this band to the rifling as well as the static inertia of the shell allows the pressure in the powder chamber to get up to the desired pressure before the shell starts to move. During the travel of the shell through the bore continued combustion of the powder maintains the pressure nearly constant compensating for the operation of Boyles' Law and giving the maximum acceleration to the projectile which the gun can successfully withstand. The chemical design of the powder makes it a progressive burning powder and allows a much greater application of acceleration to the shell. A black powder charge of equal force would probably burst the gun before the projectile started to move. The perfectly designed powder of the type now in use has its combustion complete just as the projectile moves from the muzzle of the gun.

In exterior ballistics it is necessary to consider the motion of our own ship which naturally is applied to the projectile, and the motion of the target which will displace its location during the time of flight, or the time necessary for the projectile to travel from the gun to the target. The force and direction of the wind in its effect on the projectile, deflecting the projectile in the direction of the wind's motion, and what is known as the drift of the projectile, due to its rotary motion, are also factors to be compensated. The time of flight is known from experimental data for the particular gun at the range we fire. This gives us an exact figure to develop the displacement of the shell due to our own ship's motion, and to correct the aim of the shell to take care of the displacement of the target. The drift is determined experimentally and can be given an exact figure for the range we fire. The wind must be estimated as to force and direction by observation, and the corrections for all four of these elements are applied mechanically in the sight setting by instruments designed along the basic Physics principals of speed and distance triangles.

The rotation of the projectile which I have said causes drift is the means by which we keep the long axis of the projectile pointing in the line of its trajectory throughout the whole of its parabolic flight. Please recall the laws of Gyroscopic Precession. When the projectile tends to point above the line of its falling trajectory the air pressure is unsymetrically applied relative to its center of gravity, the pointed nose loses less in its square area than it does in its cubic weight and therefore has a resultant force on

the nose pushing it up and producing a couple or moment. Gyroscopic precession necessitates a motion of the nose at right angles to the application of the force. As it moves, the deviation of the axis from the trajectory shifts as does the direction of the force applied by the air pressure, and the direction of precession. The nose of the projectile actually describes a small circle around the trajectory but due to the trajectory continually falling, the actual deflection of this circle is greater on the top and the side that it moves to from the top than it is on the bottom and on the other side. The resultant effect is that the actual travel of the shell falls off to the side, at the same time that it holds its line of axis vertically close to the falling trajectory.

It is impossible for me in the time available to do more than mention the highly complicated range keeping fire control mechanisms which, buried deep in the heart of the ship safe from hostile gun fire, collect, analyze, and disseminate the necessary information for setting the gun interval of time in advance, provided it maintains its course and speed. These instruments are electrically operated and run with a time element, and it is by means of these instruments that we can fire at targets invisible, through information supplied by aeroplane observers. The aviators estimate range and direction for the first salvo and then give corrections to bring the salvos on to the target. Through all the manifold intricacy of these range keepers with their thousands of gears and integrating mechanisms the law of Physics have guided the clever minds of the designers.

The automobile torpedo is well named since it supplies its own power from self contained air at high pressure. It has its own propelling machinery. It has its own directing mechanism, using a gyroscope to keep laterally in the line of its travel as originally aimed, and a depth mechanism, operated by the variation of pressure due to depth, to maintain it at whatever depth it has been set to travel, prior to firing. The torpedo is a valuable weapon for delivering a large charge of high explosive against the side of an enemy in its vulnerable area beneath the water line. In firing a torpedo either compressed air blows it out of an underwater tube or a light powder charge ejects it from a tube above the water, which serves to start it on its course properly pointed for the target; and a tripping mechanism operates when it leaves the tube which releases its own power to propel it to its objective. In the control of the torpedo the displacement of the target during the time the torpedo requires to travel to the target is the only element requiring correction in the sighting but in the case of fixed underwater tubes it often happens that the tube cannot be pointed at the target and in such cases the provision made for angular fire is utilized. This consists in setting the gyro on the true line of travel desired, and locking it in that position so that the torpedo will turn with full rudder into the direction of the target and then release the gyro, which from that time on will control it in a normal manner. One other form of firing torpedoes is to drop them from a low flying aeroplane. In this case the plane is pointed in the line of fire by the pilot and the torpedo dropped by a

releasing mechanism. The torpedo power plant starts upon impact with the water. The sighting device for torpedo firing on board ship is designed from the same application of the speed and distance triangles previously mentioned in connection with gun control.

In our search lights for illuminating a target at night, we apply parabolic reflectors to obtain a ray of illumination practically cylindrical. Much advance has been made in late years in the color of various light rays produced by carbons of various chemical components. Search lights are being largely replaced today, however, for night battle problems at sea, by star shells, fired from guns of three to five inch calibre, which contain a parachute supporting a light element of intense brilliancy which is released at considerable altitude above the target, when the shell bursts due to the time fuse, set for the time of flight to correspond with the range.

Aviation has become a very valuable and essential weapon of our Navy; it would be futile for me to attempt to go into the application of the laws of Physics in the subject of aerodynamics but there are one or two interesting applications of the law of Physics to the peculiar weapons of the aeroplanes. The bomb sight uses the elements of height above the targets, speed of plane, and the force and direction of the wind and, based on the well known triangle-designed mechanism, sets up the line of sight to the target which should be crossed by the plane at the instant the bomb is released. The effect of the wind in this case is on the plane itself and therefore on the bomb before it is released and of course effects the actual direction of motion of the plane over the ground, causing it to differ materially with the direction it is headed and the speed it is making through the air. On free machine guns used in planes it is necessary to have a sight to compensate for the component of the planes motion through the air which is of course dependent upon the direction of aim and operates in any of three dimensions. This is done by having a front sight mounted on a pivotal arrangement with the front sight actually displaced a distance corresponding to the average speed that the plane would travel when in combat, with a wind vane tail which causes this displacement to be directed exactly in the direction of motion of the plane, and the component of this displacement which offsets the line of sight will depend entirely upon the direction the gun is pointed. The rear sight has speed rings, concentric about the actual line of sight corresponding to an enemy plane speed of one hundred to two hundred miles per hour, and the gunner estimating the enemy speed will line up his front sight on a point in the speed ring corresponding to the speed and direction the enemy is traveling and then point this sight line at the spot he wants to hit. Here again we are using the old familiar triangles of speed and distance.

As you all know the laws of Physics govern practically every natural phenomena about us and the same applies to the Navy in all its technical elements. I have tried to explain in a very sketchy manner a few of these applications to some of our gunnery problems. I hope I have made myself fairly intelligible and not too tedious but you no doubt can appreciate that I have only brushed the surface of the subject.

SCIENCE SEQUENCE IN THE JUNIOR AND SENIOR HIGH SCHOOLS

By George William Hunter, *Claremont Colleges, Claremont, California*

Over seventy years ago Herbert Spencer sounded a note in education making science of most worth in the curriculum. To-day, in a world dominated and directed by science, we still follow Spencer's dictum. We have come to realize that although science as subject matter and method have proved their worth in the world, yet some of the curricular values we hoped for are still lacking as outcomes in the lives we are trying to educate. We still have those who think illogically and argue from false premises; we still have anti-vaccinationists and wearers of the rabbit's foot; we still remember Dayton and the Tennessee legislature.

The growth of science, particularly at the junior high school level, has been rapid. On the other hand, science in the upper grade levels is apparently losing some ground both in the numbers of courses given and numbers of students taking them. This is a matter of some concern to those of us who believe that science has definite curricular values both at the junior high school and the secondary school levels.

With this end in view the writer has continued a piece of research begun some twenty years ago. In 1908 a questionnaire was sent out to some 500 leading public high schools in various parts of the United States, and certain questions were asked which were intended to determine what factors within and without the schools were affecting the teaching of science. The findings of the questionnaire appeared in an article entitled, "The methods, content and purpose of biological science in the secondary schools of the United States," and was published in School Science and Mathematics, Vol. 10, 1910. In 1923 a similar questionnaire was sent out to the original 500 schools and to 500 additional schools. Findings from this study appeared in *School and Society* for December 13, 1924[1] and in the *School Review* for May and June, 1925.[2] In 1930 a third questionnaire was sent to the original 1,000 schools together with 500 of the leading junior high schools of the country. This

---

[1] *Is There A Sequence in Secondary School Science*, George W. Hunter.
[2] *The Place of Science in the Secondary School*, George W. Hunter.

questionnaire was rather a formidable one and asked questions with reference to aims of science at the different age levels, the placement of courses with total offerings in terms of weeks, hours per week and laboratory hours, the sequence of science in the school or school system, the enrollment today as compared with that of twenty years ago, the methods used in teaching and numerous other questions relating more directly to life science. Replies were received from 528 schools, 209 being junior high schools, 119 three-year senior high schools, and 203 four-year senior high schools. These should represent a fair sampling of the better large and small city high schools together with a fair number of the better consolidated rural high schools since the work involved in filling out the questionnaire was considerable and would only be undertaken by teachers really interested in education. In addition to the above group, the questionnaire was sent out to members of the National Association for Research in Science Teaching. Enough replies were received from this membership to make a significant check on the answers from the schools as will be seen from some of the figures that follow.

The questionnaire presented a list of science subjects, with blanks for checking each subject for *(1) Type of School, i.e. junior high school, high school, or junior college; (2) School Years Offered; (3) Number Weeks Offered; (4) Total Hours per Week; (5) Lab. Hours per Week; (6) College Entrance Credit; (7) Number Enrolled in Course.* The subjects listed were: Advanced Biology, agriculture, astronomy, bacteriology, botany, chemistry, elementary biology, elementary science, hygiene, human physiology, physics, physiography, zoology, other sciences.

These questions followed: (1) If there is an accepted science sequence please give it below, using numerals to indicate grade (e.g. Hygiene 7, 8 General Science 9, Biology 10, Chemistry 11, Physics 12, etc.). (2) State briefly your major aims in science (a) At the junior high school level; (b) At the senior high school level; (c) At the junior college level.

A second table listed the same science subjects as the first table and provided blank spaces for indicating by the numerals 1, 2, 3, etc., the relative emphasis placed on different methods of teaching each subject in the school for which the answers are given. The eight "methods" columns were headed: *Text Book, References and Reports, Individual Laboratory Work, Demonstrations, Class Discussion, Field Work and Excursions, Projects, Other Methods.*

Other questions asked were: How does the enrollment of your students in elementary science, biology, chemistry and physics courses compare with that of twenty years ago? The categories given here were *relatively more, relatively less, same.* Are your figures based on statistics? Yes...... No....... On opinion? Yes...... No....... Do you believe that the

chemistry and physics courses gain anything from the elementary science course? Check your answers. Considerably...... Little...... None....... In what respect? Are your science courses more closely related to each other and to the other science courses in the secondary school than was the case twenty years ago? Yes...... No....... Is hygiene given as a separate subject or is the tendency to make health instruction a part of the work of several departments? Yes...... No....... Indicate by numeral (e.g. 1, 2, 3, etc.) the relative emphasis you place on the following; morphology, physiology, natural history, taxonomy, ecology, relations to man, human biology, health. Why do you thus place the emphasis? To what extent are sex problems touched upon? Slightly...... Fully...... Not at all....... How do you think a course in elementary science or biology should adapt itself to the needs of the student who does not go to college, and for whom high school is the only preparation for his life work? How should the emphasis be placed in each of the four subjects (elementary science, elementary biology, chemistry, physics) at junior or senior high school level? *Utility and Information Values, Training in Scientific Method, Both Equally.*

Tables I, II and III give tabulated answers to the question, "What is the sequence of science courses in your school?"[3]

The first two tables have been reprinted from *School and Society,* December 13, 1924, while the third is new. The last table is not quite comparable since it contains information with reference to the junior high school, but the statistics on the senior high school courses are comparable since the material may be reduced to a percentage basis. The tables represent the actual placement of science courses given by teachers and are not paper conditions. In schools where a certain science course was given over a period of more than one year, only the lowest grade of offering is given. Thus, if biology is offered in the tenth year, but is offered to eleventh and twelfth year students, the course is noted as given in the tenth year. This method has been used for all data given in the three reports.

Certain significant facts are not shown in these tables. A careful perusal of the questionnaire indicates that the number of hours devoted to science is much more stabilized than in the past. "Book" courses, except in physiology and hygiene, have largely disappeared. The specialized sciences are still rapidly decreasing in offerings. Junior high school science courses usu-

[3] Division of states was made arbitrarily according to the grouping suggested by T. Q. Browne in a paper which appeared in SCHOOL SCIENCE AND MATHEMATICS in 1908. This grouping of states, although arbitrary, represents fairly well certain areas of somewhat like teaching conditions.

ally have from three to five periods a week with much more relative emphasis on demonstration than on laboratory work. The movement to do away with double periods in the senior high school is not greatly evidenced by figures, most schools reporting one or two double periods per week for the tenth, eleventh and twelfth year science. Agriculture has been included in the 1930 figures although the writer believes that this subject has been largely artificially stimulated through the Smith-Hughes Act. Courses in Agriculture naturally predominate in the Central and Great Plains states.

Reducing the figures in the three tables to a percentage basis, the tabular comparison on the following page is of interest. In this table "other sciences" include astronomy, geology, bacteriology, and psychology. If we use this percentage comparison together with the raw data assembled in the tables, we note the following rather definite tendencies.

1. General Science as such was practically unknown in 1908. Very different conditions exist today. General Science first found a place for itself in the ninth grade, but later figures indicate that there has been a spread of elementary science downward to the seventh and eighth grades although the top of the curve is still in the ninth year. The distribution of general science courses seems country wide if the raw data taken from the 1930 figures mean anything.

2. Hygiene as such has entered the junior high school and even the senior high school to a greater extent than it has in the past. The emphasis on health education is making its way from the elementary school up into the junior high school and into the senior high school. In many school systems distinct emphasis is being placed on the teaching of health habits at the seventh-grade level.

It is possible that the questionnaire does not actually show the true situation with reference to hygiene courses since the consensus of opinion among teachers is that health teaching should be indirect rather than direct. A question asking whether hygiene was given as a separate subject or whether the tendency is to make health instruction a part of the work of several departments, brought out the information that, in over forty-four per cent of the schools, reporting, health education material is a part of the work of the teachers of physical education, general science, biology and even

TABL

Science Courses Give

		Ninth Grade							Tenth		
	Number of Schools	Botany	Biology	Human physiology, hygiene	Introductory science	Physical geography	Zoology	Physics, chem., astr., geol.	Botany	Biology	Human physiology
Maine	1								1		1
New Hampshire	2	1				1	1	1	2	1	
Massachusetts	31	14	3	10	3	4	4	7	8	4	5
Vermont	1	1				1			1	1	
Rhode Island	4	3					1	1	1		
Connecticut	13	1		1	1	5		1	5	2	1
New Eng. States, Total	52	20	3	11	4	11	6	10	18	8	7
New York	39	6	28	35	1	2	2		5	1	3
New Jersey	11	2	1	4		3	2		4	1	3
Pennsylvania	25	7	1	7	1	5	2	1	6	1	3
Delaware	1										
Maryland	3					3					
Dist. of Columbia	3					3			1	1	
Middle States, Total	82	18	30	47	2	16	6	1	16	4	9
Virginia	3	1				1	1		1		
Georgia	1	1						1			
Kentucky	6			4		1	1		3		
Tennessee	2			1		1				1	
Louisiana	1	1				1					
Oklahoma	1					1			1		
Southern States, Total	14	3		5		5	2	1	5	1	
Ohio	23	8	1	8	1	9	6		10	2	3
Indiana	13	6				3	1		5		1
Illinois	28			20	1	17	2		13	2	1
Michigan	13	6		1		6	1		6	1	5
Wisconsin	10	4		5		6	2		6		4
Minnesota	5	1		1					1		
Iowa	7	5				4	1		1	1	1
Missouri	8	4	1	4		1				1	
North Cen. States, Total	107	34	2	39	2	46	13		42	7	15
North Dakota	2			2		2		1	2		
Nebraska	2	1			1				1		1
Colorado	2					2			2		
Utah	1					1			1		
Kansas	4			1		4			3		1
Rocky Mt. States, Total	11	1		3	1	9		1	9		2
California	6		1			5			2	3	
Washington	2					2			2		1
Pacific States, Total	8		1			7			4	3	1
Grand Total	276	76	36	105	9	94	27	13	94	23	34

TABLE I

…ourses Given In High Schools, 1908

Tenth Grade							Eleventh Grade								Twelfth Grade								
Botany	Biology	Human physiology	Chemistry	Physical geography	Physics	Zoology	Botany	Biology	Human physiology	Chemistry	Physical geography	Physics	Zoology	Astronomy, geology	Botany	Biology	Human physiology	Chemistry	Physics	Physical geography	Zoology	Astronomy	Geology
1		1										1						1					
2	1					2	1			1		2	1		1			2	1		1		1
8	4	5	1	3	13	10	5	3	12	17	1	20	2	4	5	4	13	22	11	3	3	2	1
1	1					1						1						1				1	1
1			1		3	1			1	2				1						2		1	2
5	2	1	1	3	2	3				3	1	4	1		1	1	1	4	3	1		2	5
18	8	7	3	6	18	17	6	3	13	23	2	28	4	5	7	5	14	30	15	6	4	6	
5	1	3		10	1	6	3			12		29	2		7			26	11	5	5		
4	1	3		1	1	2	1			1		7	2		1		1	7	1			1	1
6	1	3	2	2	1	5	2	1	1	6	1	7	5	1	1		2	8	14		2		
						3						3						3					
1	1		2		2			2		3		3	1		1	1		3	3		2		
16	4	9	4	13	5	16	6	3	1	22	1	49	10	1	10	1	3	47	29	5	9	1	1
1				1		1				1		1						1	1				
										1													
3				1		2	1			1		4			1			2	1	1		1	
	1											1											
						1						1						1					
1						1				1									1				
5	1			2		5	1			4		7			1			4	3	1		1	1
10	2	3		8		7	1	1		9	1	14	1	2	5	1	6	15	7				
5		1		5		2	2			3		7					2	6	3	1			
13	2	1		2		11				3		15						15	4			3	2
6	1	5		3		9			2	10	1	2						1	9				1
6		4		1		4	1		1	8		1	2					2	9		1		
1				4		1	3					5			3			5	2				
1	1	1		1		3				2		4	1				3	4	3			1	
	1			2	2		1			2		6	1					6		3			
42	7	15		26	2	37	8	1	3	37	2	54	6	2	8	1	11	54	37	4	1	4	4
2						2	1			2	1				1		1		2				
1		1				1						2						2					
2						1			1			2	1				1	2					
1						1						1						1					
3		1	1			1	2		1	3		2	1					1	2				
9		2	1			6	3		2	5	1	7	2		1		2	6	4				
2	3			2		2	2		1	3	1	1	2		2		3	3	2	1	1	1	
2		1				1			1			2						2					
4	3	1		2		3	2		2	3	1	3	2		2		3	5	2	1	1	1	
94	23	34	8	49	25	84	26	7	21	94	6	148	24	8	29	7	33	146	90	17	15	13	10

TABLE

Science Courses Given in Four-

	Number of Schools	Ninth Grade									Tenth Grade						
		General science	Biology	Botany	Zoology	Physiology	Chemistry	Physics	Physiography	Other sciences	General science	Biology	Botany	Zoology	Physiology	Chemistry	
Connecticut	10	9										10					
Maine	4	4										1	1				
Massachusetts	27	15		1	1	2					1	9	4	2	2		
New Hampshire	5		1	1	1			2				2	3	3	1		
Rhode Island	6	6	2			1						1	1		1	1	
Vermont	1	1															
New Eng. States, Total	53	35	3	2	2	3		2			1	23	9	5	4	1	
Delaware	1	1										1					
Dist. of Columbia	1	1										1				1	
Maryland	2	1	1									1					
New Jersey	20	17	3			1			2			17	1	1	1		
New York	51	1	45	4	2	8			1		3	9	3	2	1	1	
Pennsylvania	19	17	3	1	1	1			4			15	3	3	2		
Middle States, Total	94	38	52	5	3	10			7		3	44	7	6	4	2	
Alabama	2	2									1	1					
Georgia																	
Kentucky	2	1									1						
Louisiana	1	1		1								1	1				
Mississippi	1								1			1	1				
North Carolina	7	5	3			1						4	2			1	
Oklahoma	2	1				2			1			1	1	1	1		
Tennessee	2	2										2					
Texas	9	5		1	1	5			5		1	5	2	2	4	2	
Virginia	5	5										4	1	1	1		
Southern States, Total	31	22	3	2	1	8			7		3	19	8	4	6	3	
Illinois	31	24				16			10			20	11	8	2		
Indiana	12	4	1	2		1			3			5	5	1			
Iowa	8	6	1			1			2			6	1		2		
Michigan	11	7	1	3	1	2			1			7	4	4	2		
Minnesota	8	6				2			3			8	1				
Missouri	5	5		2		2						1	2		2		
Ohio	44	37	6	3		4			3	1		27	2	2	7		
Wisconsin	10	8	2			6			1			4	3	4	1		
North Cen. States, Total	129	97	11	10	1	34			23	1		78	29	19	16		
Arizona	2	2										2					
Arkansas	3	2				1			1			3	1		1		
Colorado																	
Idaho	1											1					
Kansas	1	1										1	1				
Montana	3	2										2	1		1		
Nebraska	6	6				2						2	4	2	1		
North Dakota	1	1											1	1	1		
South Dakota	3	3							2			3	1				
Wyoming	1									1		1					
Utah																	
Rocky Mt. States, Total	21	17				3			4	1		15	9	3	4		
California	18	13	1			1			2		1	15	4	2	1		
Oregon	3	3										3					
Washington	8	8				1			1			3	5	4	2		
Pacific States, Total	29	24	1			2			3		1	21	9	6	3		
Grand Total	357	231	70	19	7	60		2	44	2	8	200	67	43	37	6	1

TABLE II

VEN IN FOUR-YEAR HIGH SCHOOLS, 1923

Tenth Grade							Eleventh Grade									Twelfth Grade								
Botany	Zoology	Physiology	Chemistry	Physics	Physiography	Other sciences	General science	Biology	Botany	Zoology	Physiology	Chemistry	Physics	Physiography	Other sciences	General science	Biology	Botany	Zoology	Physiology	Chemistry	Physics	Physiography	Other sciences
					1						1	3	7							1	7	3	1	1
1												3	2								2	3		
4	2	2		1					2	1	2	11	13	2					1	1	13	10	1	1
3	3	1		1								3	2								4	2		
1		1	1	2	2						1	3	4				1				5	2	1	
9	5	4	1	4	3				2	1	4	23	28	2			1		1	2	31	20	3	2
													1								1			
			1	1				1				1	1				1				1	1		
												1	2				1				2	1		
1	1	1			2			1			3	5	15				2				16	6		
3	2	1	1		13			2	1	1		24	44	9			2	1	1		40	21	13	
3	3	2		1	2			1	1	1	2	12	9	1	1		1	2	1	4	10	14	3	
7	6	4	2	2	17			5	2	2	5	43	72	10	1		7	3	2	4	69	43	16	
												2										2		
				1				1				1	2	1						1	2	1		
1								1			1	1	1				1				1	1		
1												1										1		
2			1		1							6	1								1	5		
1	1	1								1			2	1						1	2	1		
													2								2			
2	2	4	2	1	3			1	2	1		5	8				1				6	5		
1	1	1			1							3	2								3	2		
8	4	6	3	2	5			3	2	2	1	19	18	2			2			2	17	18		
11	8	2			3			3	2	2	2	16	20	1			1	2	3	2	19	18	1	
5	1				4			1			1	5	8							3	8	6		
1		2			1						3	3	6					1			5	3	1	
4	4	2									1	9	2							1	2	9	1	
1												3	7								7	3		
2		2		3								3	4	2			1				4	2	3	
2	2	7			6			3	1		6	28	19					2		5	19	25	2	2
3	4	1			1							9										9		
29	19	16		3	15			7	3	2	11	76	66	3			2	5	3	11	64	75	8	2
												2										2		
1		1										3										3		
													1	1										
1													1							1	1	1	1	
1		1			1							2	1								1	2		
4	2	1							2		2	3	4								4	2		
1	1	1									1		1								1			
1												2	1							1	1	2	1	
													1								1			
9	3	4							2		3	12	10	1						2	10	13	1	1
4	2	1						1	1	1	6	16	3	2	1		1	1	1	6	3	16	2	2
													3								1	2		
5	4	2								1	1	2	6							1	6	4		
9	6	3						1	1	2	7	18	12	2	1		1	1	1	7	10	22	2	2
67	43	37	6	11	41			16	12	9	33	191	196	20	2		13	9	7	28	201	191	30	7

TABLE III

SCIENCE OFFERINGS BY S

	Junior High Schools	Three Year Senior High	Four Year Senior High	States	Courses Unplaced	VII Agriculture	VII Botany	VII Physiography	VII Elementary biology	VII Elementary science	VII Hygiene	VII Human physiology
	2		6	Connecticut							2	
			2	Maine								
	20	3	8	Massachusetts	3					11	10	1
	3	1	1	New Hampshire						2		
	3		1	Rhode Island						2	1	
	2		1	Vermont							1	
Totals	30	4	19	NEW ENGLAND						15	14	1
			1	Delaware								
				Dist. of Columbia								
	2		3	Maryland							2	
	5	4	6	New Jersey						1	4	
	17	6	37	New York	6					15	2	
	8	19	18	Pennsylvania						2	18	
Totals	32	29	65	MIDDLE STATES						18	26	
	1	1	3	Alabama	6						1	
	1			Florida								1
	2		2	Georgia							2	
	2	2	3	Kentucky				1			1	1
			4	Louisiana								
	1		3	Mississippi						1		
	1	1		North Carolina						1		
	4	1	3	Oklahoma	7					3		
	1		1	South Carolina								
		1		Tennessee						1		
	7	5	8	Texas						3		
	2		4	Virginia				1			1	
Totals	22	11	31	SOUTHERN STATES				2		9	5	2
	7	1	9	Illinois						5	1	1
	7	7	3	Indiana							2	
	10	3	5	Iowa	9					1	1	1
	23	18	2	Michigan	5					16	3	
	8	4	2	Minnesota	1	1				2	1	
	10	3	2	Missouri	1					3	3	
	10	7	17	Ohio	9			3		6	8	
	10	4	3	Wisconsin						1	3	2
Totals	85	47	43	NORTH CENTRAL STATES		1		3		34	22	4
			1	Arizona								
	1	3		Arkansas								
•	6	4	1	Colorado							1	
	1		3	Idaho								
	1	1	5	Kansas							1	
			5	Montana	1						1	
	3		3	Nebraska	4						2	
			1	New Mexico								
	2	2	2	North Dakota	4							1
	1		5	South Dakota						2		
			1	Utah								
			1	Wyoming								
Totals	15	10	28	ROCKY MT. STATES						2	5	1
	22	11	8	California	1	4	1		1	14	2	
	4		6	Oregon	5						2	
			3	Washington								
Totals	26	11	17	PACIFIC STATES		4	1		1	14	4	
528	210	112	203	GRAND TOTALS	62	5	1	5	1	92	76	8
				Per cents including hygiene		2.64	.53	2.64	.53	49.2	40.3	4.23
				Per cents excluding hygiene		4.43	.9	4.43	.9	82.5		7.1

States	VIII Agriculture	VIII Chemistry	VIII Elementary biology	VIII Elementary science	VIII Hygiene	VIII Human physiology	VIII Physiography	VIII Others
Connecticut				3	1			
Maine								
Massachusetts				16	5	1		
New Hampshire				1		1		
Rhode Island				3	1			
Vermont				1	1			
NEW ENGLAND				24	8	2		
Delaware								
Dist. of Columbia								
Maryland				3				
New Jersey				1	6			
New York		1		16	2			
Pennsylvania				3	17			
MIDDLE STATES		1		23	25			
Alabama					1			
Florida				2				
Georgia				3				
Kentucky							1	
Louisiana				1		1		
Mississippi				1	1			
North Carolina				1				
Oklahoma				3				
South Carolina				1			1	
Tennessee				1				
Texas	1			8		2	2	
Virginia	1			5				
SOUTHERN STATES	2			26	2	3	4	
Illinois				6	1			
Indiana				6	1	1		
Iowa				6	2			
Michigan	1		1	20	1			
Minnesota	1			2	3			
Missouri				8	1			
Ohio				8	7	1	2	
Wisconsin				5	2			
NORTH CENTRAL STATES	2		1	61	18	2	2	
Arizona								
Arkansas				1				
Colorado	1			3	1	1		
Idaho				2				
Kansas				1	2			
Montana					1			
Nebraska				1		1		
New Mexico								
North Dakota								
South Dakota				2				
Utah								
Wyoming								
ROCKY MT. STATES	1			10	4	2		
California	5		1	22	3	1	1	1
Oregon				3	1			
Washington								
PACIFIC STATES	5	1	1	25	4	1	1	1
GRAND TOTALS	10		2	169	61	10	7	1
Per cents including hygiene	3.9	.39	.77	64.5	23.4	3.84	2.7	.38
Per cents excluding hygiene	5.1	.5	1.	84.5		5.	3.9	.5

States	IX Agriculture	IX Botany	IX Chemistry	IX Elementary biology	IX Elementary science	IX Hygiene	IX Human physiology	IX Physics	IX Physiography	IX Zoology	Advanced biology	Agriculture	Bacteriology	Botany
Connecticut					8	2								
Maine					2									1
Massachusetts					26	6						1		2
New Hampshire					2									1
Rhode Island					4	1								
Vermont					1									
NEW ENGLAND					43	9						1		4
Delaware					1									
Dist. of Columbia														
Maryland					2		1							
New Jersey					12	1								1
New York				39	23	35		1			13			
Pennsylvania	1				12	19	1					1		18
MIDDLE STATES	1			39	50	55	2	1			13	1		19
Alabama					3	1								
Florida					1									
Georgia	1			2										
Kentucky					4	1	1		1					1
Louisiana		1		1	1									
Mississippi					3									
North Carolina				1										
Oklahoma				1	4						1			
South Carolina				2										
Tennessee		1												
Texas	1			7	5				2		1			4
Virginia	1			1	3						1			
SOUTHERN STATES	3	2		15	24	2	1		3		3			5
Illinois	1			1	11	5	5		3			1		7
Indiana	2			4	1	1			1			2		5
Iowa				2	8	2			1			4		
Michigan	1	1		3	18					1	1	1		
Minnesota				1	8							1		1
Missouri	1				9							1		
Ohio	5	2		4	20				3	2		6		4
Wisconsin				1	9	1	1							
NORTH CENTRAL STATES	10	3		16	84	9	6		8	3	1	16		17
Arizona					1									
Arkansas														
Colorado	1			1	4							1		
Idaho					1									
Kansas					3							3		
Montana	2				4							2		
Nebraska	3				4							4		
New Mexico					1									
North Dakota					2									
South Dakota					5	1			1					3
Utah														
Wyoming					1									
ROCKY MT. STATES	6			1	26	1			1			10		3
California	3			4	28		2						1	5
Oregon					6							1		1
Washington					3		1							
PACIFIC STATES	3			4	37		3					1	1	6
GRAND TOTALS	23	5		75	264	76	12	1	12	3	17	29	1	54
Per cents including hygiene	5.	1.1		15.9	56.	16.1	2.6	.2	2.6	.64	3.6	[illegible]	.22	11.7
Per cents excluding hygiene	5.9	1.3		19.	69.		3.	.75	3.	.76	4.2	[illegible]	.25	13.4

TABLE III

FERINGS BY STATES, 1930

X												XI												XII												
Agriculture	Bacteriology	Botany	Chemistry	Elementary biology	Elementary science	Hygiene	Human physiology	Physics	Physiography	Zoology	Others	Advanced biology	Agriculture	Botany	Chemistry	Elementary biology	Geology	Hygiene	Human physiology	Physics	Physiography	Zoology	Others	Advanced biology	Agriculture	Astronomy	Botany	Chemistry	Elementary biology	Geology	Hygiene	Human physiology	Physics	Physiography	Psychology	Zoology
				6											2					4	2			1		2		4		1			2	1		
		1		1					1						1					1								1						1		
1		2		8	2			1	1				1		9					4		1		2	1			4					9	1		
		1		1											2							1											2			
									1						1	1																	1	1		
				2											1					2								1								
1		4		18	2			1	3				1		16	1				11	2	2		3	1	2		10		1			14	4		
				2																	1							1								
				3											1					2								2					1			
		1		8						1				1	3	1				9		1		1				9					3			
			13	3		33		2	7			2		2	11	1		32		25	6	2		2				17			32		12	4		
1		18		23		17	1		4	15			1		33			17	1	6					1	1		7			16	14	32			1
1		19	13	39		50	1	2	11	16		2	1	3	48	2		49	1	42	7	3		3	1	1		35			48	14	48	4		1
				3											1					1				2				2					2			
				1				1							1					1								1								
		1		3						1				1	3				1	4								4	1				3			
			1	1	1	1	1	1		1					1					1																
				3											2					1								1					2			
			1																	1																
					1				1					1	2		1		1			1											2			
			1																	1																
				1											1																		1			
		4	5	4				2		2					6				1	7								2					4			
			4	1							2	1								4			1													
		5	12	17	2	1	1	4	1	4	2	1		2	17		1		3	21		1	1	2				10	1				14			
1		7		4						5		1		4	3				1	7				1		1		8		1			3			
2		5		4		1				3	1		2		9					1					2	2		1		2	2	1	9			
4				8					1		1		2		1					5					1			4				1	2			
1				14			1						1		14																		14			
1		1		8					1				1	1	6					2					1			2					6			
1				8		1									2			1		4								4					2			
6		4		15		4	5		5	3	1	1	4	3	16	1		3	1	6	1	1			3	1	1	6			2	2	18			1
				7			1								8																		8			
16		17		68		6	7		7	11	3	2	10	8	59	1		4	2	25	1	1		1	7	4	1	25		3	4	4	62			1
				1											1																		1			
				2																2								2								
1				4					1				1		1					4				1				4					1			
				3											2					1	1							1					2			
3				4		1									3	1			3	2								3				1	5			
2				5					1				2							4	1				2			5		1			1			
4				1									2							2								2								
				1			1		1											1								1								
				2									1		2					1					1			1					2			
		3		1			1			1					3					2								2					3			
				1											1				1	1								1				1	1			
				1																								1					1			
10		3		26		1	2		3	1			6		13	1			4	20	2			1	3			23		1		2	17			
	1			17			1					2	1	4	18	2			8			2	1	1		1	2			1		5	18		1	2
		5		2						3					4					2								2					4			
1		1		3								1	1	1	3																		3			
1	1	6		22			1			3		3	2	5	25	2			8	2		2	1	1		1	2	2		1		5	25		1	2
29	1	54	25	190	4	58	12	7	25	35	5	8	20	18	178	7	1	53	18	121	12	9	2	11	12	8	3	106	1	6	52	25	180	8	1	4
[illegible]	.22	11.7	5.42	41.	.86	12.6	2.4	1.52	5.42	7.6	1.1	1.8	4.5	4.	39.8	1.6	.22	11.9	4.05	27.2	2.7	2.	.45	2.64	2.9	1.9	.72	25.5	.24	1.44	12.5	6.	43.	1.9	.24	.96
[illegible]	.25	13.4	6.2	46.9	1.		3.	1.74	6.22	8.7	1.24	2.	5.1	4.5	45.4	1.8	.26		4.58	30.8	3.06	2.3	.5	3.	3.3	2.2	.83	29.1	.28	1.65		6.87	49.2	2.2	.28	1.1

TABLE IV

PERCENTAGES OF DIFFERENT SCIENCE COURSES OFFERED AT VARIOUS GRADE LEVELS DURING 1908, 1923 AND 1930 AS SHOWN BY RETURNS OF QUESTIONNAIRES

	Ninth Year			Tenth Year			Eleventh Year			Twelfth Year		
	1908	1923	1930	1908	1923	1930	1908	1923	1930	1908	1923	1930
General Science	2.5	53.10	66.9		1.93	6.99						
Elementary biology	10.0	16.09	18.99	7.25	48.13	46.9	2.09	3.47	1.8	1.95	2.67	.275
Botany	21.1	4.37	1.27	29.98	16.22	13.4	7.79	2.5	4.5	8.05	1.85	.825
Zoology	7.5	1.60	.76	26.5	10.41	8.7	7.19	1.87	2.3	4.17	1.44	1.1
Human physiology	29.17	14.72	3.04	10.72	8.95	2.99	6.29	6.88	4.58	9.01	5.97	6.87
Chemistry				2.52	1.45	6.22	28.14	39.64	45.4	40.55	41.38	29.1
Physics		.43	.21	7.88	2.66	1.74	41.31	40.91	30.8	25.0	39.30	49.21
Physiography	26.11	10.11	3.04	15.46	9.92	6.22	1.81	4.18	3.16	4.72	6.17	2.2
Other sciences	3.61	.43				1.24	2.39	.41	.75	6.38	1.44	4.25
Advanced biology						4.24			2.0			3.03
Agriculture			5.84			7.2			5.1			3.31

English, history and civics, as it undoubtedly should be.[4]

Another finding is that general biology is still firmly ensconced in the tenth grade. Although there appears to be a distinct tendency toward a movement downward in certain states, perhaps it would be more correct to say that this tendency is a spread in both directions. In New York State statistics given by the University of the State of New York indicate a very considerable number of students taking advanced biology in the tenth, eleventh and twelfth years. Their recent new course of study for tenth year biology indicates that this one state, which has been out of step with the rest of the country for some time, is coming into line with the general trends.

The situation with reference to the chemistry-physics sequence is still unsettled, some states giving chemistry in the eleventh year followed by physics, and other states giving just the opposite sequence. In Pennsylvania, Michigan, Indiana, Massachusetts, Ohio, California, Wisconsin, Washington and Oregon, there is a distinct tendency toward chemistry in the eleventh and physics in the twelfth year. In Connecticut, New Jersey, New York, Illinois, Iowa, Missouri, Colorado and Montana there seems to be fairly well established the reverse sequence of physics in the eleventh and chemistry in the twelfth year.

TABLE V

Numbers and Percentages of Science Courses Offered on Each Grade Level in Junior and Senior High Schools

Grades	General (Elem.) Science		Elementary Biology		Chemistry		Physics	
	Courses	Per cent	Courses	Per cent	Courses	Per cent	Courses	Per cent
7	93	17.4	1	.38				
8	169	31.7	2	.77				
9	264	50.1	75	28.00			1	.30
10	4	.77	190	67.60	25	8.3	7	1.97
11			7	2.70	178	58.0	121	41.00
12			1	.38	106	33.8	180	56.70

A glance at the graph (page 221) indicates that the sequence which places chemistry in the eleventh year and physics in the

[4] Swalwell, B. L. "Teaching Health in the High School." *University of Iowa Extension Bulletin,* Number 115, January 1, 1925.

twelfth year is gaining ground. Findings based on state courses of study indicate the following:

	Seventh Year	Eighth Year	Ninth Year	Tenth Year	Eleventh Year	Twelfth Year
12 states with clear preferred sequence	Elem. Sci.	Elem. Sci.	Gen. Sci.	Biology	Chemistry	Physics
3 states	Elem. Sci.	Elem. Sci.	Gen. Sci.	Biology	Physics	Chemistry
1 state			Gen. Sci.	Biology	Chemistry-Physics	Physics-Chemistry
1 state			Gen. Sci.	Biology	Physics-Chemistry	Chemistry-Physics
6 states			Gen. Sci.	Biology	Chemistry-Physics	Chemistry-Physics

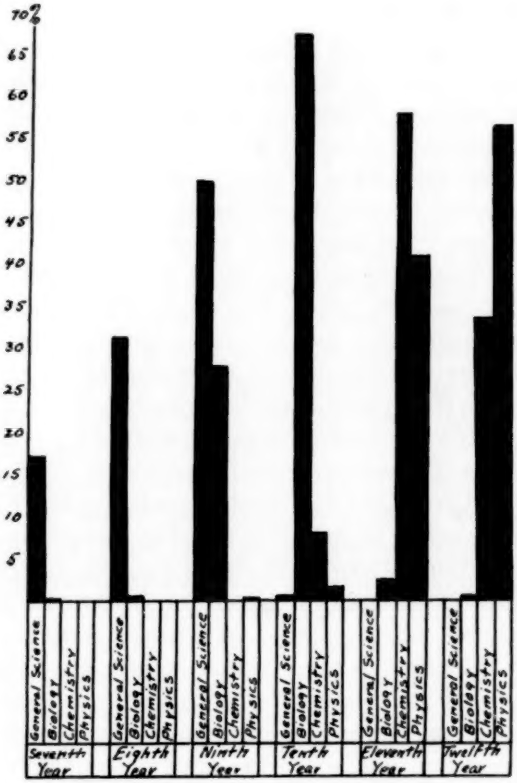
Other interesting tendencies are that physiography, once a leading first year subject, has decreased rapidly in the number of courses given and has reduced its holdings in all four years of the secondary school so that it now occupies a relatively unimportant position. Even more noticeable is the decrease in botany and zoology in the tenth year as well as in the eleventh and twelfth. According to the returns from the questionnaire, Pennsylvania in the East, Oregon in the Far West and some of the states in the agricultural belt of the Central West still give botany and zoology in place of biology, although even in these states sentiment is mixed.

Enrollment in the special sciences is relatively small, botany, human physiology, zoology, astronomy and geology apparently ranking in the order given. Two new sciences appear, namely, bacteriology and psychology, but the offerings are few and the number of students enrolled is very small.

This somewhat lengthy questionnaire can not be discussed further except to say that answers indicate that a much greater proportionate number of students are taking science courses now than twenty years ago. Most of the increases come with the junior high school science, but a considerable portion of it comes in the ninth and tenth grades. Phillips[5] in his statistics of public high school reports in 1927-28: 7,686 schools give biology to 183,151 boys and 210,240 girls, a total of 393,391; general science is taught in 9,845 schools to 356,866 boys and 250,172 girls, a total of 507,038. He states that 4,783 schools are giving chemistry with an enrollment of 118,641

[5] Phillips, F. M., "Statistics of Public High Schools" *Bulletin 35*, 1929. U. S. Bureau of Education, Dept. of the Interior.

boys and 86,053 girls or a total of 204,694 while 7,346 schools give physics courses to 180,209 boys and 68,193 girls or a total of 248,402.



Percentage distribution of the four major divisions of science taught in the junior and senior high schools. Note that the total distribution of general or elementary science in grades 7, 8, 9 and 10 equals 100%.

Curtis[6] in a recent article gives the following statistics based on returns from 1,802 high schools in the North Central Association.

	General Science	Biology	Chemistry	Physics
Boys	43,245	37,622	38,225	39,644
Girls	47,494	44,283	25,697	14,130

[6] Curtis, "The Teaching of Science in Secondary Schools," *North Central Association Quarterly*, March, 1932.

These figures bear out in general the returns from my questionnaire except that the proportionate enrollment in physics and chemistry is somewhat higher than the returns from this questionnaire indicate.

In answer to a question asking for a comparison of the relative numbers of students taking science today as compared with the relative number taking science twenty years ago, the following figures are of interest. Ninety-five per cent of the schools answering say they have proportionately more students enrolled in general science than twenty years ago, 3 per cent less, and 2 per cent about the same; 86.1 per cent of the schools have more students enrolled in biology, 8.2 per cent less, and 5.7 per cent about the same; 71.9 per cent of the schools answering have more students enrolled in chemistry, 18.1 per cent have fewer and 19.5 per cent about the same. In physics 52.3 per cent have proportionately more students taking physics, 30.5 per cent have fewer while 17.2 per cent have about the same. These figures are interesting in comparison with some obtained from the National Association for Research in Science Teaching. The group answering gave figures for the state of New York, Detroit, Philadelphia, Pittsburgh and Sacramento, as well as figures from several of the practice schools of the teachers' colleges. These individuals gave the following statements. Eleven said there was a greater enrollment in elementary science; ten a greater enrollment in biology, one a smaller enrollment; five said chemistry had a greater enrollment, five less and one about the same. Four said physics has greater, five less, one about the same, These figures are significant to teachers of science because they come from sources which would be favorable rather than unfavorable to science and yet all indications are that the specialized sciences of the upper high school level are steadily losing ground in spite of the very much larger enrollment in elementary science.

Hoping to receive some hint as to the possible reason for this, the following questions were asked. Do chemistry and physics gain anything from the earlier science courses? The summary from both the National Association for Research in Science Teaching group and the teachers who answered the questionnaire indicates that a very considerable number believed that there are considerable gains. Two hundred and nine stated that these sciences gained considerably; 116, that there

is little gain and 18 that there is no gain. The respects in which the gains were made are specifically as follows:

	Frequency
Backgrounds, fundamental concepts in the field of science	132
Increased interests	56
Improved method of attack, ability to use the method of science, problem solving	51
Attitudes, skills	32
Terminology, nomenclature	29
Laboratory techniques	24
Exploration, survey of field, orientation	23
Ability to evaluate evidence, scientific thinking, clearer thinking	15

Among other gains might be mentioned the following: information, acquisition of facts, greater powers of observation, increasing experience, breadth of view, appreciations, and larger science enrollment. One interesting correlation was observed. In most of the schools which said there was little gain from the work previously given, there was a falling off of enrollment in physics and chemistry.

One other question is interesting in this respect. "Are the science courses more closely related to other courses in the secondary school than they were twenty years ago?" 299 said that there was greater correlation, 31 no correlation, and 14 said very little, or qualified their answers. This may or may not have significance. It is evident from the figures given above that although science has made tremendous strides in the junior high school and in the lower senior high school levels, the specialized sciences are steadily losing ground at the upper age levels. With science holding the place in the world that it does today, these figures are cause for thought on the part of supervisors and teachers of science.

NEW THEORY OF EARTH ORIGIN SUGGESTED BY HARVARD ASTRONOMER

The earth and the moon were born out of the parent spiral nebula that fathered not only the sun but all the other stars of the Milky Way, is the suggestion of Dr. Harlow Shapley, of Harvard, made at the meeting of the American Association for the Advancement of Science. This scrapping of the most widely accepted theories of the origin of the earth and other planets of the sun's family is sure to create great interest and fresh thought among astronomers.

The Shapley theory makes the moon, planets and sun all the same age, the progeny of a "secondary swirl or eddy of the parental spiral nebula out of which the local galaxy or Milky Way may be supposed to have generated." The conventional theory is that the earth and planets were born when a passing star pulled matter like gaseous taffy out of the sun, and some have theorized that the moon was cleaved off the earth at an even later time.

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON
State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor, should have the author's name introducing the problem or solution *as on the following pages.*

The Editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS OF PROBLEMS

Note.—Persons sending in solutions should read carefully the instructions about the form of the solutions and the ink-drawn figures. Many times, a good solution is received, but poorly arranged and no India-ink figure given. Contributors are requested to give their full address. This is for the convenience of friends of this department who write for this information.—Editor.

LATE SOLUTIONS

1240. *Guy C. Lentini, Boston, Mass., Ricardo G. Tarlac, Manila, P. I.*

1242, 1244. *John E. Bellards, St. Nazianz, Wis.*

1246. *Proposed by Gunther Wunsche, Dresden, Germany.*

In a parallelogram $ABCD$, M lies on AB and N on BC. Through D lines are drawn parallel to AN and CM. The area of the parallelogram thus formed is to the area of the original parallelogram as AB is to BC.

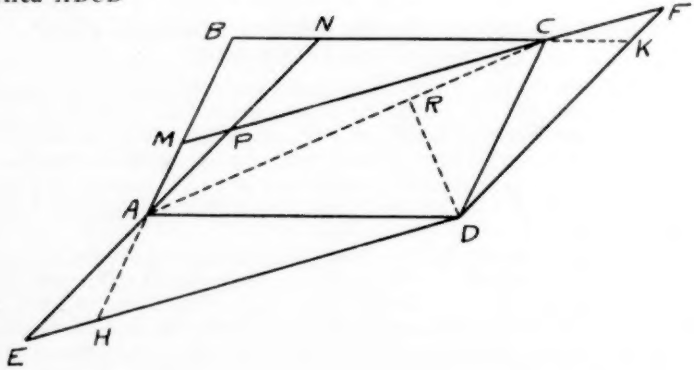
Solved by Charles W. Trigg, Cumnock College, Los Angeles, Calif.

The general case of this proposition is not true.

Since $\Delta ABN \cong \Delta DCK$, and $\Delta MBC \cong \Delta HAD$,

Parallelogram $EPFD >$ Parallelogram $ABCD$ by the magnitude of $\Delta AEH + \Delta CFK + BMPN$.

$$\therefore \frac{\text{Area } EPFD}{\text{Area } ABCD} > 1.$$



If $AB=BC, \dfrac{AB}{BC}=1$; if $AB<BC, \dfrac{AB}{BC}<1$; hence the proposition can only be true if $\dfrac{AB}{BC}>1$, i.e. $AB>BC$.

Consider a parallelogram which meets this condition. As M and N approach B, area $EPFD$ approaches area $ABCD$ and $\dfrac{\text{area } EPFD}{\text{area } ABCD}$ approaches 1.

As N approaches C and M approaches A, EP and PF approach AC and their magnitude increases indefinitely. The altitude of $EPFD$ approaches RD, and the area $EPFD$ increases indefinitely. Hence, $\dfrac{\text{area } EPFD}{\text{area } ABCD}$ increases indefinitely. But, in a given parallelogram, $\dfrac{AB}{BC}$ is constant.

$\therefore$ the proposition is only true for a parallelogram in which $AB>BC$, and then only for a special case where M and N are definitely located so as to yield the desired relationship.

This problem was similarly discussed by D. Moody Bailey, Athens, W. Va.

1247. *Proposed by Andrew Sabczyk, Duluth, Minn.*

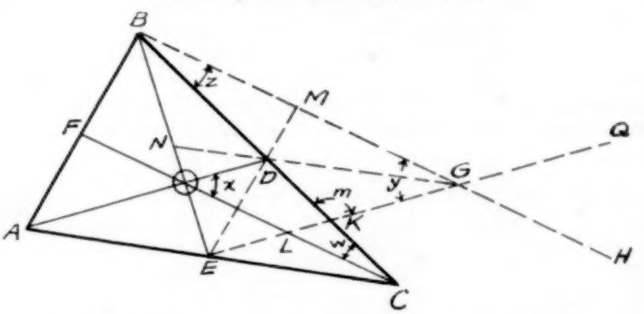
Solve for x: $x+\log_a x=a$

This problem did not appear in correct form originally. No solution has been received for the correct form as given above and in the December issue.

1248. *Proposed by Norman Anning, University of Michigan.*

A triangle with sides a, b, and c, and with medians d, e, and f, and with area A is given. A second triangle with sides d, e, and f, is constructed, and also a third triangle with sides equal to the medians of the second. This process is continued indefinitely. Prove that the third triangle is similar to the first. Prove that the sum of all the areas is $4A$, and that the sum of all the perimeters is $4(a+b+c+d+e+f)$.

Solved by A. MacNeish, Chicago



Let ABC be the given Δ and BE, AD, and CF be the medians: $BE=e$, $AD=d$, $CF=f$, $AB=c$, $AC=b$, and $BC=a$.

Draw BH from $B\|CF$, and EQ from $E\|AD$, BH and EQ intersecting at G.

$\angle ODC=\angle m$ and $\angle z=\angle w$ being alternate interior $\angle s$ of $\|$ lines.

Therefore $\Delta ODC \backsim \Delta BKG$ and $\dfrac{KG}{OD}=\dfrac{KB}{DC}=\dfrac{BG}{OC}$ i.e. $\dfrac{KG}{\frac{1}{3}d}=\dfrac{KB}{\frac{1}{2}a}=\dfrac{BG}{\frac{2}{3}f}$.

Now in ΔBEK, $OD \| EK$, so $\frac{BO}{BE} = \frac{BD}{BK} = \frac{OD}{EK}$, i.e. $\frac{\frac{2}{3}e}{e} = \frac{\frac{1}{2}a}{BK} = \frac{\frac{1}{3}d}{EK}$.

Therefore $\frac{2}{3}BK = \frac{1}{2}a$ or $BK = \frac{3}{4}a$, but $BD = \frac{1}{2}a$, so $DK = BK - BD$ or $\frac{3}{4}a - \frac{1}{2}a = \frac{1}{4}a$, and K is the mid point of DC.

The first proportion therefore reads $\frac{KG}{\frac{1}{3}d} = \frac{\frac{3}{4}a}{a\frac{1}{2}} = \frac{BG}{\frac{2}{3}f}$.

Therefore $KG = \frac{\frac{3}{4}a}{\frac{1}{2}a} \cdot \frac{1}{3}d = \frac{1}{2}d$ and $BG = \frac{\frac{3}{4}a}{\frac{1}{2}a} \cdot \frac{2}{3}f = f$.

L is the mid-pt. of OC since K is mid-pt. of DC and $LK \| OD$.

Therefore $LK = \frac{1}{2}OD = \frac{1}{2}(\frac{1}{3}d) = \frac{1}{6}d$.

From the second proportion above $OD = \frac{2}{3}EK$ and $OD = \frac{1}{3}d$, so $\frac{2}{3}EK = \frac{1}{3}d$.

Therefore $EK = \frac{3}{2} \cdot \frac{1}{3}d = \frac{1}{2}d$.

$EG = EK + KG = \frac{1}{2}d + \frac{1}{2}d = d$.

Since $BE = e$ and $BG = f$ and $EG = d$, ΔBEG is the second Δ whose sides are equal to the medians of the first triangle, ABC.

Moreover BK is a median of ΔBEG since EK has been proved $= KG$, and $BK = \frac{3}{4}a$.

Since $BD = \frac{1}{2}a$ and $DK = \frac{1}{4}a$, D is the point on the median BK where the other two medians of ΔBEG intersect BK,

Therefore ED extended to BG is a median of ΔBEG and GD extended to BE is a median of ΔBEG.

Let M be the point where ED meets BG, therefore M is mid-pt. of BG.

Let N be the point where GD meets BE, therefore N is mid-pt. of BE.

Since E is mid-pt. of AC and D is mid-pt. of BC, therefore ED, $\| AB$ and, $= \frac{1}{2}AB$ or $\frac{1}{2}c$.

$DM = \frac{1}{2}ED = \frac{1}{2} \cdot \frac{1}{2}c = \frac{1}{4}c$, therefore $EM = \frac{3}{4}c$.

Similarly, N is mid-pt. of BE and D is mid-pt. of BC.

Therefore GN is $\|$ to EC and $ND = \frac{1}{2}EC = \frac{1}{2}(\frac{1}{2}b) = \frac{1}{4}b$,

But $GD = 2ND = 2(\frac{1}{4}b) = \frac{1}{2}b$,

Therefore $GN = \frac{3}{4}b$.

Therefore the medians of the second Δ are to the sides of the first Δ as 3 is to 4.

Now if the third Δ be constructed with the medians of the second Δ as its sides, the sides of the third Δ will be to the sides of the first Δ as 3 is to 4 and the third Δ will therefore be similar to the first Δ since their sides are proportional.

Therefore area of third Δ is to area of first Δ as 9 is to 16.

Area of second $\Delta = 2$ (area of $\Delta BEK) = 2(\Delta BEC - \Delta EKC) = 2(\frac{1}{2}A - \frac{1}{8}A)$ $2(\frac{3}{8}A) = \frac{3}{4}A$.

Δ	Sides	Medians	Perimeters	Areas
ABC	a, b, c	d, e, f	$a+b+c$	A
BEG	d, e, f	$\frac{3}{4}a, \frac{3}{4}b, \frac{3}{4}c$	$d+e+f$	$\frac{3}{4}A$
Third	$\frac{3}{4}a, \frac{3}{4}b, \frac{3}{4}c$	$\frac{3}{4}d, \frac{3}{4}e, \frac{3}{4}f$	$\frac{3}{4}(a+b+c)$	$^{9}/_{16}A$
Fourth	$\frac{3}{4}d, \frac{3}{4}e, \frac{3}{4}f$	$^{9}/_{16}a, ^{9}/_{16}b, ^{9}/_{16}c$	$\frac{3}{4}(d+e+f)$	$^{27}/_{64}A$
etc.	etc.	etc.	etc.	etc.

The sum of the perimeters of the first two Δ's makes the first term of a geometric series in which the sum of the perimeters of the third and fourth Δ's makes the second term and so on, the ratio being 3 to 4.

Therefore the sum of all the perimeters

$$\text{or } \Sigma p = \frac{(a+b+c+d+e+f)\ ((\frac{3}{4})^{\infty}-1)}{\frac{3}{4}-1} = \frac{-(a+b+c+d+e+f)}{-\frac{1}{4}}$$
$$= 4(a+b+c+d+e+f)$$

The areas of the successive Δ's form a geometric series in which the first term is A and the common ratio is 3 to 4.

Therefore the sum of all the areas or

$$\Sigma A = \frac{A((\frac{3}{4})^{\infty}-1)}{\frac{3}{4}-1} = \frac{-A}{-\frac{1}{4}} = 4A.$$

Also solved by W. E. Buker, Leetsdale, Pa., W. E. Batzler, Battle Creek, Mich., Charles W. Trigg, Los Angeles, Calif., and D. Moody Bailey, Athens, W. Va.

1249. *Proposed by R. T. McGregor, Elk Grove, Calif.*

If $a^2+b^2=7ab$, show that $\log [\frac{1}{3}(a+b)] = \frac{1}{2}(\log a + \log b)$.

Solved by Josephine Katzka, Oshkosh, Wisconsin

1. $a^2+b^2=7ab.$
2. $a^2+2ab+b^2=9ab.$
3. $(a+b)^2=9ab.$
4. $(a+b)=3\sqrt{ab}.$
5. $\frac{1}{3}(a+b)=\sqrt{ab}.$
6. $\log [\frac{1}{3}(a+b)] = \frac{1}{2}(\log a + \log b).$

Also solved by G. C. Lentini, Boston, Mass., Charles W. Trigg, Los Angeles, Calif., Jack W. Noll, Johnston, Pa., John W. Bellards, St. Nazianz, Wisconsin, W. E. Buker, Leetsdale, Pa., A. MacNeish, Chicago, Samuel Weiss, Ann Arbor, Mich., Norman Anning, University of Michigan, W. E. Batzler, Battle Creek, Mich., Gordon Duvall, Oxford, Ohio, Lee T. Low, Ada, Oklahoma, D. Moody Bailey, Athens, W. Va., and Sudler Bamberger, Harrisburg, Pa.

1254. *Determine the number of zeros at the end of 1000!*

Solved by Norman Anning, University of Michigan.

Every zero at the end of the value of factorial 1000 arises from the product of a 2 and a 5. Exploration similar to what follows for 5 shows that factorial 1000 contains the 994th power of 2.

In factorial 1000 there are			200	numbers divisible by			5.
Of these	200	" "	40	"	"	"	5^2.
Of these	40	" "	8	"	"	"	5^3.
Of these	8	" is	1	number	"	"	5^4.
Total			249				

Factorial $1000 = 2^{994}\cdot 3^{498}\cdot 5^{249}\cdots 991^1\cdot 997^1$.

Consequently factorial 1000 ends in 249 zeros.

By-product: The number of zeros at the end of factorial n is approximately $\frac{n}{4}$.

Also solved by Victor R. Cox, Wichita, Kan., and V. Carlos Shafer, Le Mars, Iowa.

Several incomplete solutions giving 211 as the answer were received.

1255. *Proposed by Charles Louthan, Columbus, Ohio.*

The combined surface area of a sphere and cube is to be minimized while keeping the combined volume constant. Find the ratio of the radius to the edge.

Solved by Sudler Bamberger, Harrisburg, Pa.

Let S_c and V_c denote the combined surfaces and volumes respectively, r the radius of the sphere and e the cube's edge. Then $4\pi r^2+6e^2=S_c$ and $\frac{4}{3}\pi r^3+e^3=V_c$.

$$S_c = 4\pi r^2+6\left(V_c-\frac{4}{3}\pi r^3\right)^{2/3}.$$

V_c by hypothesis is constant.

$$\frac{dS_c}{dr} = 8\pi r+\left(V_c-\frac{4}{3}\pi r^3\right)^{-1/3}(-16\pi r^2).$$

When S_c is a minimum $\frac{dS_c}{dr}=0$. If $r\neq 0$, the equation becomes

$$\frac{1}{e}=\frac{1}{2r}.$$

Hence, $\frac{r}{e} = \frac{1}{2}$.

Also solved by W. E. Buker, Leetsdale, Pa., Claude H. Hills, Kirksville, Missouri, Samuel Weiss, Ann Arbor, Mich., and D. Moody Bailey, Athens, West Virginia.

HIGH SCHOOL HONOR ROLL

The Editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

For this issue the Honor Roll appears below.

1249. Harold Riley, Lewis and Clark High School, Spokane, Wash., Norman Pearson, Waukegan (Illinois) High School.

1254. Henry Luster, Simon Gratz High School, Philadelphia, Pa.

PROBLEMS FOR SOLUTION

1268. *Proposed by Charles Lonthan, Columbus, Ohio.*

Find the indefinite integral $\frac{(\log x)^5}{x}\,dx$.

1269. *Proposed by C. C. Hunt, Cedar Rapids, Iowa.*

On sides AC and BC of the triangle ABC, construct parallelograms $ACHI$ and $BCGF$ external to the triangle. Produce IH and FG to meet at K. Draw KC and extend it to meet AB in R. At A and B draw lines parallel to KR meeting IK in D and FG in E. Prove that $ABED$ is a parallelogram whose area equals the sum of the areas of the parallelograms $ACHI$ and $BCGF$.

1270. *Proposed by Norman Anning, University of Michigan.*

The equation $x^{10}=10^x$ has two roots other than the obvious root 10 Find the negative root correct to four significant figures.

1271. *Proposed by H. Grossman, New York City.*

The sum of the 2nd, 4th, 6th, etc. in the expansion of $(a+b)^n$ is 2^{n-1}. The sum of the 3rd, 6th, 9th, etc. coefficients differs from $\frac{2^n}{3}$ by less than 1.

1272. *Proposed by W. E. Batzler, Battle Creek, Mich.*

If two tangents are drawn to a circle from an external point, then the distance from any point on the minor arc to the chord of contact is the mean proportional between the distances to the two tangents from the same point.

1273. *Proposed by W. E. Buker, Leetsdale, Pa.*

Evaluate $\lim_{x\to\infty} x(a^{1/x}-1)$, $a>0$.

FROM THE SCRAPBOOK OF A TEACHER OF SCIENCE

By Duane Roller,

The University of Oklahoma, Norman, Okla.

As biologists it does not matter to us whether the higher forms of life actually emerged from the lower ones or not. The hypothesis that they did so emerge correlates our observations, as well as a conception as it would do as a reality, and we can therefore employ it so long as it continues to be of value.—*Prof. Herbert Dingle, in "Science and Human Experience."*

Men sometimes speak as though the progress of science must necessarily be a boon to mankind, but that, I fear, is one of the comfortable nineteenth century delusions which our more disillusioned age must discard.—*Bertrand Russell.*

I have come to have very profound and deep-rooted doubts whether science, as practiced at present by the human race, will ever do anything to make the world a better and happier place to live in, or will ever stop contributing to our general misery as whole-heartedly as it has been doing these last umtedee years. —*Hendrik Van Loon.*

O star-eyed Science! hast thou wandered there
To waft us home the message of despair?
—*Thomas Campbell, in "Pleasure of Hope."*

Taken as a whole the machine age has not been detrimental to the world; but just at the present moment it appears so. The problems of the moment may lead to their solutions.—*Albert Einstein, as quoted by "Time," March 14, 1932*

I teach you the Overman. Man is something which shall be surpassed.—*Fredrich Wilhelm Nietzsche, in "Thus Spake Zarathustra."*

Love is founded on hate, so get up a fight on the moon and thus unite the world.—*Andre Maurois, in "The Next Chapter."*

Mathematics is the science which draws necessary conclusions. —*Benjamin Peirce, "American Journal of Mathematics," 4, 97 (1881).*

SCIENCE QUESTIONS

Conducted by Franklin T. Jones, 10109 Wilbur Avenue, Cleveland, Ohio

Readers are invited to co-operate by proposing questions for discussion or problems for solution.

Examination papers, tests, and interesting scientific happenings are very much desired. Please enclose material in an envelope and mail to Franklin T. Jones, 10109 Wilbur Avenue, Cleveland, Ohio.

SUGAR-OFF AT HUDSON, MARCH 18, 1933

615. *By Bill Vinal.*

"Ye never kin tell but Hi Simons reckons the sap will be running March 18, 1933. Says to tell ye that he's got them elderberry spouts all cut and that he has whittled out some real old-fashion hickory paddles for stirring the syrup. The buckets are all polished and ready to hang. Hi says him and Cy Hoskins will begin to gather sap about 1:30 P.M. by the Academy clock."

Now you'll want to see the whole sugar making process so be on hand early with your kodak. Bring your market baskets and get sugar maple twigs, chips, and leaves to show the boys and girls at home.

NORTH EASTERN OHIO SECTION OF THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS *invites teachers, their wives, husbands, sons, daughters, and friends to come to Hudson, Ohio, on Saturday, March 18, 1933. Make it a big day. The biggest and jolliest gathering of Science and Mathematics Teachers ever held in Ohio.*

OHIO, PENNSYLVANIA, WEST VIRGINIA, AND INDIANA ESPECIALLY INVITED

Historic Western Reserve Academy.

The first Astronomical Observatory west of the Alleghenies.

Where Professor Morley determined the Atomic Weight of Oxygen.

The old Congregational Church where they know how to "sugar-off."

A Program of Scientific Questions and Answers by Boys of Western Reserve Academy, East Technical High School, Cleveland Heights, John Hay and wherever they come from to all their Teachers, especially to Dr. Harold S. Booth, Associate Professor of Chemistry, Adelbert College; Dr. J. J. Nassau, Professor of Astronomy, Case School of Applied Science, concerning

"WHAT THE PIONEERS KNEW ABOUT SCIENCE"

See Ray Wilson's home-made six-inch Reflecting Telescope.

Program begins at 9:30 A.M.

A Lunch at Western Reserve Academy. (Please let R. B. Simon, Hudson Ohio, know you are coming)—Dutch treat.

An Afternoon in Hi Simons' sugar-bush.

Supper and Sugar-Off at the Congregational Church. (Again, tell Simon you are coming.) Supper 50¢ or thereabouts.

An evening under the Stars. Cuddle down under the old buffalo robe . . . and drive home.

Maple sugar—the gift of the Indians to the early settlers.

And all this for wampum of 50¢, or thereabouts, per plate.

Don't forget to let Simon know you are coming.

Hudson, Ohio, on Pennsylvania R.R. and Ohio Route 8.
MEET IN THE SUGAR BUSH, MARCH 18.

EDISON GENERAL SCIENCE TEST

614. *General Science test submitted by H. K. Moore, Thomas A. Edison School, Cleveland, Ohio.*

There are 52 questions on the first part of this test which will be published in two instalments. The first instalment appeared in January. The second instalment appears below. EDITOR.

THOMAS A. EDISON SCHOOL GENERAL SCIENCE TEST, GRADES 7, 8, and 9.
CONSTRUCTED BY H. C. MCGUFFY, L. D. MENNEL AND H. K. MOORE
Name...................... Homeroom............ Score......

Directions: Some of the following statements are right; some are wrong. If a statement is entirely true, place a plus sign (+) in the parenthesis; if wrong place a zero (0) in the parenthesis. Study the samples before beginning. They are correctly marked. Do not guess.

Sample: The sun gives off light and heat........................(+)
Sample: The earth is flat like a board.........................(0)

1. Small seeds are strong. They can be planted deep............( )
2. Dark colored soils are usually richer than light colored soils...( )
3. A magnet will attract coins...............................( )
4. Peaches and apples can be grown on the same tree............( )
5. Fresh vegetables are high in vitamins and food value.........( )
6. A Canadian Soldier (May Fly) lives 3 years at the bottom of lakes, etc...( )
7. A pair of scissors is an example of a lever..................( )
8. Humus is largely made up of decayed plant material.........( )
9. Many garden insects live over the winter in rubbish and old stems...( )
10. After the lawn has been mowed, the clippings should be raked up...( )
11. Sunlight increases the growth of bacteria....................( )
12. Big bodies of water heat quickly and cool quickly............( )
13. Distillation may be used to separate mixtures of liquids......( )
14. Water may be siphoned from the cellar to the attic..........( )
15. Temperature is measured in calories........................( )
16. Platinum is a more useful metal than iron...................( )
17. Oxygen is an element.......................................( )
18. An automobile engine is an internal combustion engine.......( )
19. Steam is an invisible gas...................................( )
20. Its power of expansion and compressibility enables steam to do work...( )
21. Part of the Big Bear forms the Big Dipper...................( )
22. Liquids are made up of rapidly moving particles.............( )
23. Gases are expansible but not compressible...................( )
24. Waves of radio frequency can be heard......................( )
25. The step-up transformer has more turns on the primary......( )
26. A current of electricity is produced by a stream of electrons...( )
27. A cell consists of a number of batteries.....................( )
28. An electric fuse is a safety device..........................( )

29. Recovering original form after distortion is called elasticity....( )
30. Kinetic energy is energy in the process of performing work....( )
31. The boiling point of water is higher on a mountain than at its base..( )
32. The greater the number of vibrations per second the lower the pitch..( )
33. Sound can be transmitted through a vacuum................( )
34. Wood and metals are good transmitters of sound.............( )
35. Sound travels faster through air than through water..........( )
36. The resistance in a wire converts electric energy into heat.....( )
37. The hole through which the light passes to the inner eye is the retina..( )
38. Glass tubes with large bores are called capillary tubes........( )
39. The fusion point is the temperature at which a material either melts or solidifies....................................( )
40. Specific gravity is loss of weight in water plus weight in air...( )
41. A material through which light will not pass is opaque.......( )
42. Zero is the freezing point of water on the Fahrenheit scale....( )
43. Weight is a measure of the force of gravity.................( )
44. Exclaiming "ouch!" when burned is an example of a reflex action..( )
45. The feeling that people are discussing one behind his back is an example of suspiciousness................................( )
46. Adhesion is the tendency of molecules of water to cling together.( )
47. There are 1000 centimeters in one meter...................( )
48. An ordinary gas engine is a 6 cycle engine..................( )

The score for this page is the number right minus the number wrong.

CHEMICAL COMPLETION TEST

616. *The clipping below appeared in The Cleveland Plain Dealer.*

KNEW WATER'S WEIGHT

CHIEF HALTS GASOLINE FIRE DUE TO HIS CHEMICAL KNOWLEDGE

Kansas City, Jan. 8—(AP)—Because Fire Chief Michael Mahoney knew water is heavier than gasoline a threatening oil blaze here was extinguished today.

A gasoline tank car was enveloped in flames after two garage workers started draining the contents into a storage tank. The valve at the bottom of the car stuck, allowing gasoline to flow along the ground to embers of a fire.

Chemicals and hoses failed to halt the blaze. The chief arrived and noticed the manhole at the top of the tank car was open.

Question: What did the chief order his men to do?
How did they put out the fire?
Complete the above with a common sense, scientifically sound solution.

TRICK QUESTIONS

Please send them in, also tests, questions, problems. One received from J. A. Nyberg will be published next month.

BOOK REVIEWS

A Short Course in Trigonometry, by James G. Hardy, Professor of Mathematics in Williams College. Cloth. Pages ix+181+xx+142. 14.5 x 20.5 cm. 1932. The Macmillan Company, 60 Fifth Avenue, New York. Price $2.25.

This trigonometry belongs to the traditional type. It is written for students of some maturity. The functions are defined in the first chapter for the acute angle. The general definitions are introduced in the second chapter. We find numerous problems, some involving little manipulation and designed to develop insight, others providing practice in the manipulation of trigonometric relations, and still others providing applications.

There is an extensive collection of tables covering 142 pages. Besides the usual trigonometric and logarithmic tables, we find a five place table of powers, roots, and reciprocals; a table of natural logarithms; values and logarithms of hyperbolic functions; values and logarithms of haversines; tables of compound interest and discounts; present value of an annuity; and four place tables of logarithms and antilogarithms.

J. M. Kinney

Practical Tree Surgery, by Val T. Hanson, Tree Surgeon. Cloth, 12 x 19 c. m. 101 pp. illustrated with 45 figures. 1932. C. C. Nelson Publishing Co. Appleton, Wisconsin. Price $1.50.

This is an excellent book for the amateur horticulturalist or amateur tree surgeon who may have occasional jobs in this line. The directions for work are very explicit and simple, amplified by pertinent illustrations as the work proceeds. All phases of tree surgery are very carefully covered.

Besides tree surgery the book includes directions and advice on other related subjects. Some of these are: the selection and planting of trees, pruning; undernourished trees; drought and asphyxia; wind and ice damage; destructive insects, and insecticides, fungicides and fumigants; and a final chapter on the apple orchard.

We feel that this is an unusually good book putting, as it does, such valuable information in very compact and usable form.

W. Whitney

Cultural Natural Science, by Paul A. Maxwell, Professor of Education. State Teachers College, Peru, Nebraska. Cloth. Pages 80+Appendix and illustrative units. Willioms and Wilkins Co. Baltimore, 1932. Price $2.00.

This investigation is an attempt to develop materials and methods to satisfy one major kind of education, cultural education, or education which offers guidance in the selection and pursuit of worthy diversions.

The author selected 421 themes from popular scientific literature. Each theme selected satisfied four criteria: (1) range, (2) quality (3) scope, and (4) wording. These themes were then evaluated by sixteen evaluators selected for their broad knowledge of subject matter, familiarity with the tastes and abilities of junior high school pupils, and an understanding of the characteristics of cultural natural science as distinguished from practical natural science. On the basis of this evaluation 108 themes were retained.

Four themes were selected for illustrative learning exercises. They were tried out in a large number of schools under satisfactory experimental conditions. In the basis of these trial experiments, the author makes the following recommendations:

(1) Cultural Natural Science should be developed as a distinct part of the junior high school curriculum.

(2) Cultural natural science in the junior high school should be an elective department.

(3) Teachers of cultural natural science should guide pupils in the selection of their objectives, and in the selection and performance of their learning activities.

This review sketches only a few of the main features of this investigation. The statistical treatment is complete. The material for the four themes is given in full in the appendix. Because this investigation develops a new type of material to satisfy an objective which is becoming more important in educational procedures, it is important that teachers make a careful study of its contents and methods to be better prepared to assist pupils in a more worthy use of their leisure time.

I. C. D.

An Experimental Study of Superstitions and Other Unfounded Beliefs as Related to Certain Units of General Science, by Otis W. Caldwell, Director of the Institute of School Experimentation, Teachers College, and Gerhard E. Lundeen, Institute of School Experimentation. Paper. Pages 138. Bureau of Publications, Teachers College. 1932. Price $1.25.

This experimental study attempts to discover a logical way of incorporating discussions of commonly accepted unfounded beliefs into related subject matter in general science and to determine whether desired attitudes may be developed by direct and specific instruction regarding common beliefs, that have little or no basis in facts. Three units, "food and health," "the earth and other heavenly bodies" and "weather conditions" furnish the material for the study. Reading material in textbooks and reference books is suggested and additional supplementary reading is provided to give a well rounded presentation. Discussion of common erroneous beliefs is incorporated. Teaching tests discover to what extent changes are made in the attitude of the pupils toward these unfounded beliefs.

The evidence collected seems to indicate that specific instruction concerning unfounded beliefs is effective in changing attitudes toward such beliefs. This evidence is based on answers pupils give to certain questions and not to their reactions to situations which may be influenced by belief in unfounded ideas.

We need many more studies of this nature in all branches of science. They will have far reaching effect on choice of subject matter, methods of teaching, and in purposes.

I. C. D.

An Investigation of Content and Mastery of High School General Science Courses, by Ellwood D. Heiss, head of the Department of Science, State Teachers College, East Stroudsburg, Pa. 1932. Cloth. Pages 118. Published by the Author. Price $1.50.

This investigation is divided into three main problems:

1. To ascertain the basic facts, principles and applications of science around which general science courses are built for the ninth grade.

2. To determine the extent of mastery of these basic facts and principles.

3. To study the relation of intelligence to achievement in general science.

The facts and principles are selected from eight widely used textbooks

and are grouped into twelve units. Mastery tests of the multiple-choice type are constructed to test mastery of the facts and principles selected. Tables are given to indicate to what per cent each question in each unit is answered correctly. Copies of the tests are included in the appendix.

The summary, conclusions and implications are clearly stated and are well worth the careful study of all teachers interested in the teaching of general science.

I. C. D.

The Interpretation of the Atom, by Frederick Soddy of Oxford University, England. Cloth. Pages xviii+355. 14 x 20.5 cm. 1932. G. P. Putnam's Sons, 2 West 45th Street, New York, N.Y. Price $5.00.

This book is a development of the author's *The Interpretation of Radium* published nearly a quarter of a century ago. He has reorganized the old material, which has now become classical, added the results of the experiments of recent years, and has frankly criticized the theories of today. Many will not agree with some of his criticism but his discussion points out weaknesses and will tend to check the quite common error of enthusiasts to accept theory as fact.

In Part I, *The Radioactive Elements and Isotopes*, the author gives a thorough discussion of the subject he has so ably helped to develop. Beginning students will find these chapters intensely interesting and very helpful in getting clearly in mind the difficult and arduous experimentation which led to the discovery of radioactivity and to the unfolding of atomic disintegration. Disintegration series, isotopes, and the nature of α-, β- and γ-rays are clearly discuss d.

Part II, *The General Progress of Atomic Chemistry*, includes discussion of "Matter and Electricity," "Theory of Relativity," "The Structure and Spectrum of the Atom," "Quantum Theory," "The Periodic Table," "Chemical Affinity," "The Atomic Nucleus," "Radioactivity and the Universe," and other related topics. Some of these topics are thoroughly treated, especially those most closely related to experimental facts; but in other cases the treatment is more superficial and much of the work of theoretical and mathematical physics is severely criticised. The author is very skeptical of the value of the Bohr theory, wave mechanics and the theory of relativity, yet frequently makes use of parts of them and, in a few cases, accepts other theories less carefully organized and tested. Notwithstanding these faults, the book is an outstanding review of the progress of the study of the atom and makes available in one volume the necessary historical matter, an ample supply of experimental description and results, and sufficient theory discussion to give an intelligent understanding of this field of science.

G. W. W.

THE TEN MARK OF AN EDUCATED MAN

He keeps his mind open on every question until the evidence is all in.
He always listens to the man who knows.
He never laughs at new ideas.
He cross-examines his day-dreams.
He knows his strong point and plays it.
He knows the value of good habits and how to form them.
He knows when not to think and when to call in the expert to think for him.
We can't sell him magic.
He lives the forward-looking, outward-looking life.
He cultivates a love of the beautiful.—Albert Edward Wiggam.